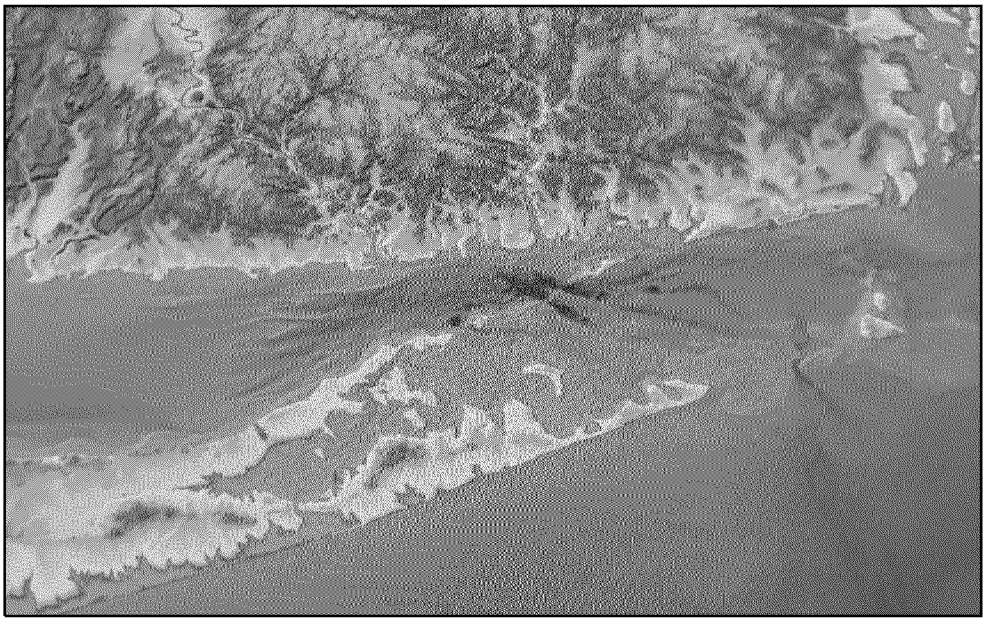
Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Eastern Long Island Sound, Connecticut and New York

Literature Search / Data Gap Assessment



Prepared for: **United States Environmental Protection Agency**

Sponsored by: **Connecticut Department of Transportation**

Prepared by: **Louis Berger**

and the

University of Connecticut

October 2013

ED_001437D_00000426-00001

[This page intentionally left blank.]

Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Eastern Long Island Sound, Connecticut and New York

---

LITERATURE SEARCH / DATA GAP ASSESSMENT

Prepared for:
United States Environmental Protection Agency
5 Post Office Square, Suite 100
Boston, MA 02109

Sponsored by:
Connecticut Department of Transportation
Waterways Administration
2800 Berlin Turnpike
Newington, CT 06131-7546

Prepared by:
The Louis Berger Group, Inc.
117 Kendrick Street
Needham, MA 02494

and the

University of Connecticut
Department of Marine Sciences
1080 Shennecossett Road
Groton, CT 06340

October 2013

[This page intentionally left blank.]

Table of Contents

ED_001437D_00000426-00005

APPENDICES

List of Tables

ED_001437D_00000426-00007

List of Figures

ED_001437D_00000426-00008

ED_001437D_00000426-00009

ED_001437D_00000426-00011

Acronyms and Abbreviations

AIS	Automatic Identification System
AWOIS	Automatic Wreck and Obstruction Information System
BIS	Block Island Sound
BOEM	Bureau of Ocean Energy Management
CASE	Connecticut Academy of Science and Engineering
CFR	Code of Federal Regulations
CLIS	Central Long Island Sound
cm	centimeter(s)
CCMA	Center for Coastal Monitoring and Assessment
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDOT	Connecticut Department of Transportation
CTDPH	Connecticut Department of Public Health
CPUE	Catch per Unit Effort
DAMOS	Disposal Area Monitoring System
DDT	Dichlorodiphenyltrichloroethane
DMMP	Dredged Material Management Plan
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ELIS	Eastern Long Island Sound
ESI	Environmental Sensitivity Index
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GPS	Geographic Positioning System
LIDAR	Laser Interferometry Detection and Ranging
LIS	Long Island Sound
LISICOS	Long Island Sound Integrated Coastal Observatory System
LISS	Long Island Sound Study
LNG	Liquefied Natural Gas
LWRP	Local Waterfront Revitalization Program
m	meter(s)
MDMF	Massachusetts Division of Marine Fisheries
MPRSA	Marine Protection, Research, and Sanctuaries Act
n/a	not applicable

ED_001437D_00000426-00012

NCCOS National Centers for Coastal Ocean Science

NEAMAP North East Area Monitoring and Assessment Program

NEPA National Environmental Policy Act

NLDS New London Disposal Site

NMFS National Marine Fisheries Service

NOAA National Oceanic and Atmospheric Administration

NOS National Ocean Service

NROC Northeast Regional Ocean Council

NS&T National Status and Trends

NYSDEC New York State Department of Environmental Conservation

NYSDOH New York State Department of Health

NYSDOS New York State Department of State

ODA Ocean Dumping Act (see MPRSA)

PAHs Polycyclic aromatic hydrocarbons

PCBs Polychlorinated Biphenyls

PCDD/Fs Polychlorinated dibenzodioxins and furans

REMOTS Remote Ecological Monitoring of the Seafloor (sediment profile camera imagery)

RICRMC Rhode Island Coastal Resources Management Council

RIEDC Rhode Island Economic Development Corporation

RIDEM Rhode Island Department of Environmental Management

RIDFW Rhode Island Division of Fish and Wildlife

RIDOH Rhode Island Department of Health

RIGIS Rhode Island Geographic Information System

RIR Rhode Island Region

RNC Raster Navigational Chart

SAMP Special Area Management Plan

SAV Submerged Aquatic Vegetation

SEIS Supplemental Environmental Impact Statement

SHPO State Historic Preservation Officer

SUNY State University of New York

TOC Total organic carbon

UCONN University of Connecticut

URI University of Rhode Island

URI-GSO University of Rhode Island Graduate School of Oceanography

USACE U.S. Army Corps of Engineers

ED_001437D_00000426-00013

USEPA U.S. Environmental Protection Agency
USFWS U.S. Fish and Wildlife Service
USGS U.S. Geological Survey
WLIS Western Long Island Sound
WHG Woods Hole Group
ZSF Zone of Siting Feasibility

ED_001437D_00000426-00014

EXECUTIVE SUMMARY

In preparation for the Supplemental Environmental Impact Statement (SEIS) for designating dredged material disposal sites in the Eastern Long Island Sound, this literature review and data gap assessment provides a broad summary of the available data and information. Specifically, data are required for three primary purposes: (1) Screening of potential alternative disposal sites within the Zone of Siting Feasibility (ZSF); (2) Preparation for fieldwork during 2013 to address data gaps; and (3) Preparation of the SEIS. The ZSF consists of Eastern Long Island Sound (ELIS) and Block Island Sound (BIS).

The literature review and data gap assessment concluded the following:

Suitability of Existing Data. Data and information that are readily available and identified in this literature search, as well as data and information considered likely to be available from state and federal agencies, universities, and other organizations, are considered suitable for a general characterization of the ELIS and BIS regarding potential project-related impacts to resources. Data are also considered for initial screening of potential disposal sites in the ZSF; however, additional information may need to be obtained through project-specific field investigations and modeling.

Primary Resource Considerations for Site Screening. The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) provides criteria to be considered in the evaluation and designation of ocean dredged material disposal sites. Based on the review of the existing information for the ZSF, the following resources and other issues and factors are considered the most relevant decision criteria for the selection of potential disposal sites within the ZSF:

- *Water depth:* Greater water depths reduce susceptibility to sediment resuspension.
- *Physical oceanography:* Currents and waves affect transport of sediment during and subsequent to disposal, including resuspension and redistribution of deposited sediment during storms.
- *Benthic habitat (sediment texture and seafloor morphology):* Sediment texture and seafloor morphology affect the suitability of the habitat for benthic organisms (including lobsters, crabs, oysters, worms, etc.).
- *Shellfish resources, zoning, and commercial and recreational harvesting:* Shellfish resources include oysters, clams, scallops, and lobsters. There is considerable annual and spatial variability that needs to be considered during the data analysis for these resources.
- *Finfish resources, and commercial and recreational fishing:* Fisheries data indicate that fishing occurs throughout the ZSF, although locations with unusual seafloor morphology (*e.g.*, deep holes) may result in localized special conditions.
- *Navigation and infrastructure:* There is active commercial vessel traffic in the ZSF and there are five anchorage areas. Infrastructure in the ZSF consists of cables.

- *Conservation areas:* Beaches, parks, nature preserves, etc. are located in coastal and nearshore areas throughout the ZSF.
- *Archaeological resources:* Shipwrecks are scattered throughout the ZSF.
- *Active and historic disposal sites:* There are two active and seven historic disposal sites in the ZSF.
- *Interference with other uses of the ocean (shipping, fishing, recreation, etc.):* Available information includes future dredging needs by the communities surrounding the ZSF to maintain harbors and coastal facilities to allow access to the ocean.

Initial Site Screening. Based on primary resource considerations, the initial screening under MPRSA has identified 11 sites for further consideration.

Next Steps. Additional data and information to be obtained and reviewed include the following:

- *Physical oceanographic study:* The bottom stress needs to be determined (through fieldwork and modeling) as it affects the resuspension and transport of sediment at potential disposal sites. Field measurements, to be made during different seasons with varying environmental conditions, include current profiles, wave fields, and water column characteristics. The sediment resuspension potential during extreme events (*i.e.*, storms) needs to be modeled and the path of resuspended sediment needs to be evaluated, using collected field data as part of the model input. Similarly, the transport of suspended sediment during dredged material disposal operations needs to be modeled.
- *Field studies and surveys:* More detailed data and information are required for NEPA analysis of environmental resources at potential alternative disposal sites:
    - Benthic organisms and sediment characteristics (grain size, chemistry [metals, organic compounds, total organic carbon]).
    - Substrate and benthic habitat information for some of the initially screened alternative sites.
    - Commercial and recreational fishing information for lobster and sport fish.
- *Other steps:* Existing data need to be analyzed and reviewed to obtain a better understanding of conditions at initially screened sites, including:
    - Benthic habitat, through review of available videos and bottom photographs.
    - Fisheries for finfish and shellfish, using trawl survey data and other fisheries data.
    - Infrastructure, to determine if cables and anchorages are in active use or abandoned.
    - Archaeological resources, by coordinating with tribes and State Historic Preservation Officers (SHPOs).

1. INTRODUCTION

In 2005, the U.S. Environmental Protection Agency (USEPA) designated dredged material disposal sites in western and central Long Island Sound (WLIS/CLIS), following the preparation of an EIS. The two disposal sites in ELIS, Cornfield Shoals and New London, are scheduled to close in December 2016. The USEPA has started preparing a SEIS for the potential designation of one or more open-water dredged material disposal sites needed to serve the ELIS region. Aside from the ELIS, the ZSF includes BIS (Figure 1).

The SEIS will be prepared in accordance with Section 102(c) of the MPRSA; also referred to as the Ocean Dumping Act (ODA) of 1972. The USEPA has the responsibility of designating sites under Section 102(c) of the Act and 40 CFR Part 228.4 of its regulations. The SEIS is supported by the State of Connecticut through the Connecticut Department of Transportation (CTDOT).

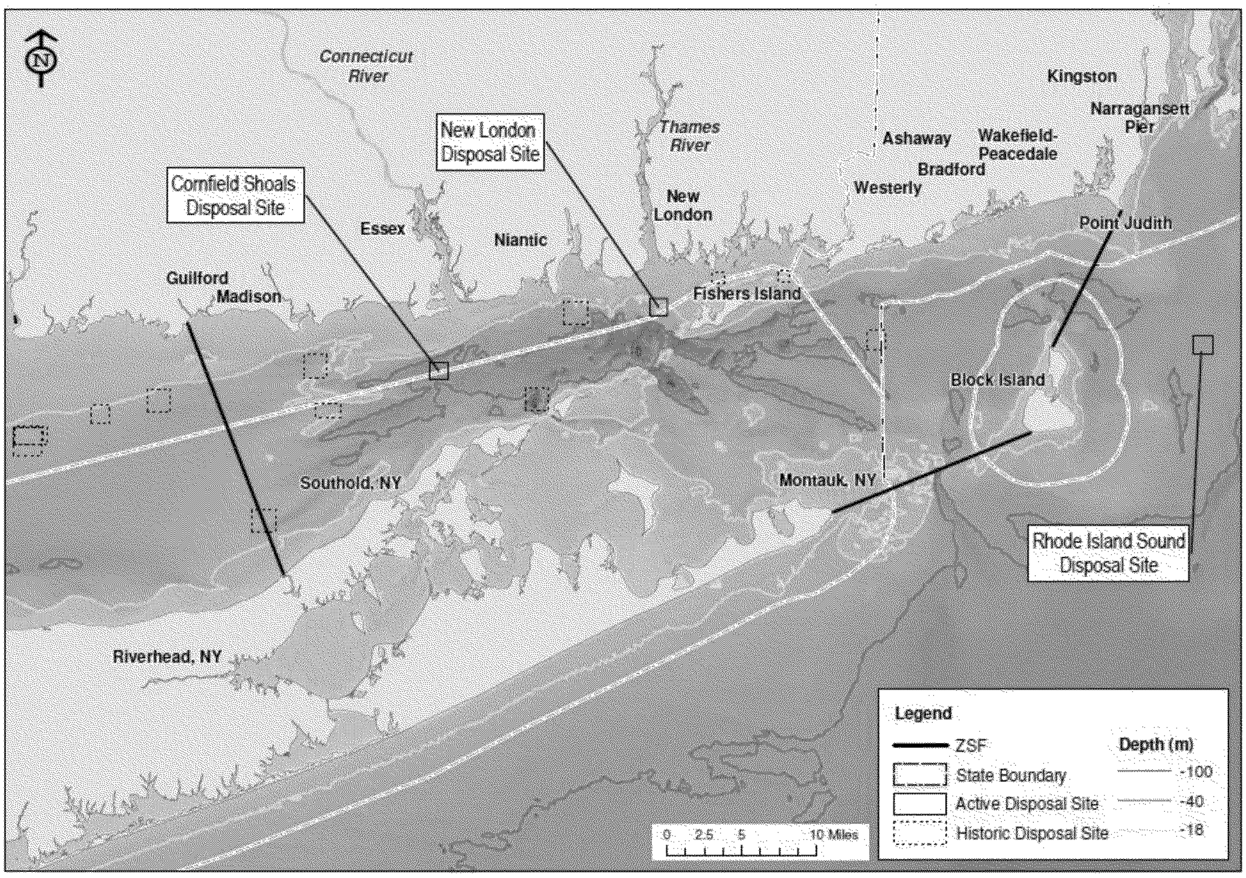


Figure 1. Zone of Siting Feasibility (ZSF) considered during the literature review and data gap analysis.

ED_001437D_00000426-00017

In preparation for the SEIS, the literature search and data gap analysis was designed to achieve the following objectives:

- **Alternative Disposal Site Screening:** Review of available resource data within the ZSF for initial screening of potential alternative dredged material disposal sites.
- **Preparation for fieldwork in the summer and fall of 2013:** Identification of critical data gaps that need to be addressed through field data collection to facilitate the alternative site selection and subsequent NEPA analysis for the SEIS.
- **Identification of additional information needed for the preparation of the SEIS**.

The data gap analysis included a broad, initial review of available data and information sources. If suitable, data were compiled spatially using Geographic Information Systems (GIS). The more in-depth data review to be conducted during the preparation of the SEIS, after selecting alternative disposal sites for more detailed NEPA analysis, is expected to reveal additional data gaps, which will be addressed at that time.

2.0 APPROACH

2.1 Review of WHG (2010) Database *(prepared by Battelle, February 14, 2013)*

Battelle (2013) analyzed the *Long Island Sound (LIS) Dredged Material Management Plan (DMMP) Phase 2 Literature Review Update*, prepared by the Woods Hole Group (WHG) for the U.S. Army Corps of Engineers (USACE), hereafter referred to as WHG (2010). Battelle's initial review was used in this report as a point of departure to further assess data gaps.

WHG (2010) provided a list of 209 references pertinent to dredging in general and within Long Island Sound (LIS) specifically. This list updated a literature review completed by Battelle in 2001 for the CLIS/WLIS EIS (USEPA and USACE, 2004a). WHG (2010) focused on updating documents not addressed by, or newly available after the completion of, the CLIS/WLIS literature review. Based on WHG (2010), Battelle (2013) identified the following water bodies and regions as pertinent to the ELIS SEIS:

- Block Island Sound
- Cornfield Shoals
- Eastern LIS
- Entire LIS
- Gardiners and Peconic Bays
- New London
- Shoreline Connecticut
- Shoreline New York
- Shoreline Rhode Island
- Upland Connecticut
- Upland New York

Battelle reviewed the documents listed in WHG (2010) for possible applicability to these general locations. Any documents that could not be assigned to a location within the ZSF for the ELIS SEIS were grouped into a "Supporting References" category. Table 1 is a summary of the WHG (2010) documents, grouped by water body and region.

Along with determining the applicability of each document to a water body/region within the ZSF for the ELIS SEIS, Battelle reviewed documents for applicability to the following primary topics that will likely be addressed in the ELIS SEIS. This list is drawn from the 5 general and 11 specific ocean disposal site criteria listed in the MPRSA and subsequent amendments.

1. Benthic (Macro-Invertebrate) Resources
2. Coastal Management
3. Ecology, Habitats, and Species
4. Economic Data and Analysis
5. Environmental Evaluation and Economics of Disposal Options
6. Fisheries / Shellfisheries

7. Fishing Activities and Human Health Risks
8. General Interest
9. Geology and Geomorphology
10. Historic, Cultural, and Archaeological Resources
11. Historic Disposal Activities and Disposal Sites
12. Marine Wildlife and Endangered Species
13. Physical Impacts of Fishing Activities
14. Physical Oceanography
15. Public Parklands, Beaches, and Sanctuaries
16. Sediment
17. State Dredged Material Disposal Guidance
18. Water Quality

Table 2 summarizes the number of documents by topic and MPRSA relevance.

Battelle reviewed the 209 document abstracts summarized in WHG (2010) and determined that approximately 105 documents contained data relevant to the environment in ELIS. Appendix A lists those references, the water body to which the data may be pertinent, the type of document, and the topic to which the data may apply with respect to the MPRSA, the operative regulation for the ELIS SEIS. Appendix B lists the other 104 documents in WHG (2010) that potentially contained data that could inform about dredged material management effects in general, but were not directly relevant to the ZSF screening.

This first-order initial review by Battelle (2013) was limited to evaluating the document titles, summaries, and entries in WHG (2010) against the MPRSA criteria for open-water disposal and the data needs for describing the environment and natural resources within the ZSF for the ELIS SEIS. Therefore, the review only assessed whether a document could potentially be applicable and provide information.

In this literature review, we considered the literature summary prepared by Battelle (2013), along with additional data and information sources described in Sections 2.2 and 2.3, below.

ED_001437D_00000426-00020

Table 1. Literature Summary by Primary Topic and Region (Battelle, 2013)

	Number of References [1]												
Topic	**Block Island Sound**	**Cornfield Shoals**	**Eastern LIS**	**Entire LIS**	**Gardiners and Peconic Bays**	**New London**	**Shoreline CT**	**Shoreline NY**	**Shoreline RI**	**Upland CT**	**Upland NY**	**Supporting References**	**Total**
Benthic (Macro-Invertebrate) Resources			1					1				7	9
Coastal Management				3			2	2			1	3	11
Ecology, Habitats, and Species			2	9			1	4		4	1	16	37
Economic Data and Analysis													
Environmental Evaluation and Economics of Disposal Options	2			3							4	59	68
Fisheries/Shell Fisheries	3			19			3			1		1	27
Fishing Activities/Human Health Risks				3									3
General Interest				2					1	1	1	1	6
Geology and Geomorphology			2	5								1	8
Historic, Cultural, and Archaeological Resources													
Historic Disposal Activities and Disposal Sites		1	2									12	15
Marine Wildlife & Endangered Species				1						1	1		3
Physical Impacts of Fishing Activities													
Physical Oceanography	1		3									3	7
Public Parklands, Beaches, Sanctuaries							1						1
Sediment	2	1	4	8								18	33
State Dredged Material Disposal Guidance				2				2	1			5	10
Water Quality			1	17			2			1		7	28

[1] Note that some documents reviewed were pertinent to more than one primary topic. The numbers represented here include all documents pertinent to that primary topic.

Table 2. Literature Summary: Type of Study and Relevant MPRSA Criteria Region (Battelle, 2013)

Assessment Type	Number of References reviewed		
	ELIS	Sup-porting	Total
TYPE OF STUDY			
Environmental Analysis	23	15	38
Field Sampling	22	22	44
Laboratory Analysis/Tests	0	7	7
Model	2	5	7
Monitoring	16	11	27
Baseline Characterization	0	0	0
Impacts Analysis	0	0	0
Historical	0	0	0
Review	8	30	38
Regulatory/Manuals	13	8	21
Other (Data Comparison, Directory, Forum for Current Research)	21	6	27
MPRSA CRITERIA			
40 CFR Sec. 228.5 – General Criteria			
a) Minimize interference w/other activities, avoiding existing fisheries or shellfisheries, regions of heavy commercial or recreational navigation.	25	0	25
b) Initial mixing from disposal is expected to be reduced to normal ambient seawater levels or undetectable contaminant concentrations before reaching any beach, shoreline, marine sanctuary, or known geologically limited fishery or shellfishery.	31	0	31
c) If any existing interim sites are found not to meet criteria (sec. 228.5–228.6), use will be terminated as soon as alternate site can be designated.	0	0	0
d) Size of disposal sites will be limited to allow for effective monitoring and surveillance programs to prevent adverse long-range impacts.	4	0	4
e) USEPA will, wherever feasible, designate ocean dumping sites beyond continental shelf and other such sites that have been historically used.	1	0	1
40 CFR Sec. 228.6(a) – Specific Criteria			
1. Geographic position, depth of water, bottom topography, and distance from shore.	6	0	6
2. Location relative to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases.	35	0	35
3. Location relative to beaches or other amenity areas.	8	0	8
4. Types and quantities of wastes proposed to be disposed of, proposed	2	0	2

ED_001437D_00000426-00022

Assessment Type	Number of References reviewed		
	ELIS	Sup-porting	Total
methods of release, include methods of packing waste, if any.			
5. Feasibility of surveillance and monitoring.	5	0	5
6. Dispersal, horizontal transport, and vertical mixing characteristics of area; includes prevailing current direction and velocity, if any.	14	0	14
7. Existence and effects of current and previous discharges and dumping in area (includes cumulative effects).	6	0	6
8. Interference w/shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance, and other legitimate uses of ocean.	28	0	28
9. Existing water quality and ecology of site as determined by available data or by trend assessment or baseline surveys.	73	0	73
10. Potential for development or recruitment of nuisance species in disposal site.	3	0	3
11. Existence at or near site of any significant natural or cultural features of historical importance.	4	0	4

2.2 Other Data and Information Sources

Aside from WHG (2010) , additional data and information sources were reviewed for th is data gap assessment to capture the most recent information available, as well as data and information that is unique to the ELIS SEIS and therefore not included in the broader data and information search by WHG (2010).

2.2.1 Review of Existing Key Documents

Key documents reviewed consisted of the following:

- *Environmental Impact Statement for the Designation of Dredged Material Disposal in Central and Western Long Island Sound, Connecticut and New York* (USEPA and USACE, 2004 a): Information and references in this document for several resource categories apply to the entire LIS, including the ELIS.
- *Rhode Island Region Long-term Dredged Material Disposal Site Evaluation Project – Final EIS* (USEPA and USACE, 20 04b): The ZSF for the RIR EIS is shown in Figure 2 ; its westernmost part overlaps with the ZSF for the ELIS SEIS.

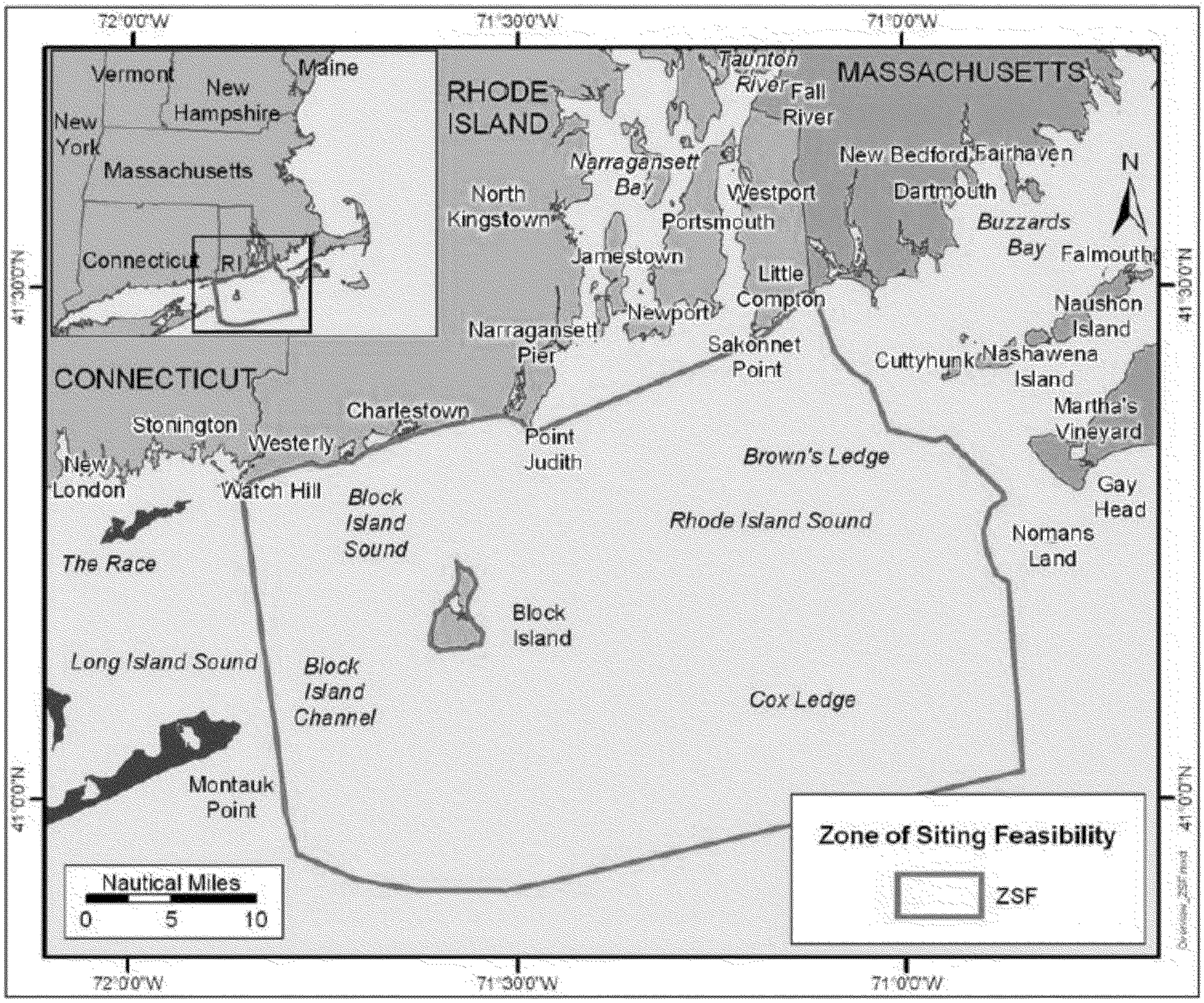


Figure 2 . Zone of Siting Feasibility for the Rhode Island Region (RIR) EIS (USEPA and USACE, 2004b).

2.2.2 Review of other Documents and Selected References

Specific documents (identified by WHG [2010] and within the key documents above) were reviewed in greater depth. These documents include, for example, the Environmental Impact Statement for the Broadwater Liquefied Natural Gas (LNG) Terminal in central Long Island Sound (FERC, 2008) and the USACE's Disposal Area Monitoring System (DAMOS) reports, as well as relevant scientific publications.

2.2.3 Contacting Resource Agencies and Researchers

Resource agencies and researchers were contacted to inquire about additional relevant information (Table 3).

Table 3. List of Resource Agencies and Researchers Contacted

Issues discussed	Name	Email	Telephone
New York State Department of State (NYSDOS)			
Conservation areas; fisheries, finfish, and shellfish resources	Jennifer Street	jennifer.street@dos.ny.gov	518-474-1737
	Rebecca Newell	rebecca.newell@dos.ny.gov	518-474-6000
New York State Department of Environmental Conservation (NYSDEC)			
Finfish fisheries	Steve Heins	swheins@gw.dec.state.ny.us	631-444-0435
Connecticut Department of Energy and Environmental Protection (CTDEEP)			
Fisheries, finfish, and shellfish resources	George Wisker	george.wisker@ct.gov	860-424-3034
	David Simpson	david.simpson@ct.gov	860-424-3727
	Deb Pacileo	deb.pacileo@ct.gov	860-434-6043
Rhode Island Coastal Resources Management Council (RICRMC)			
Rhode Island Ocean Special Area Management Plan (SAMP)	Jeffrey Willis	jwillis@crmc.ri.gov	401-783-3370
University of Connecticut (UCONN), Department of Marine Sciences			
Eelgrass information	Jamie Vaudrey	jamie.vaudrey@uconn.edu	860-405-9149
Sediment transport	Frank Bohlen	walter.bohlen@uconn.edu	860-405-9176
Deep water corals; benthic habitat	Peter Auster	peter.auster@uconn.edu	860-405-9121
Benthic environment	Robert Whitlatch	robert.whitlatch@uconn.edu	860-405-9154
Underwater videography	Ivar Babb	ivar.babb@uconn.edu	860-405-9119
University of Rhode Island (URI)			
Sediment grain size and chemistry in BIS	John King	jking@gso.uri.edu	401-874-6182
U.S. Geological Survey (USGS)			
Sediment texture, bathymetry, benthic photographs	Larry Poppe	lpoppe@usgs.gov	508-457-2314

2.2.4 Web Links

Web links accessed during the literature review are listed below; several of these links were provided by George Wisker (CTDEEP), Jeffrey Willis (RICRMC) , Jennifer Street (NYSDOS), and others.

- *Long Island Sound Resource Center:* http://www.lisrc.uconn.edu/lisrc/index.asp (contains many images plus bathymetry, geology, and some benthic data; a clearinghouse of subsea data for Long Island Sound, although many elements may be dated at this point or of value only for historical trends).

- *Northeast Ocean Data Portal:* http://northeastoceandata.org/ (planning-level data for New England and LIS).

- *Northeastern Regional Association of Coastal and Ocean Observing Systems:* http://www.neracoos.org/ (contains observation/forecast information for ocean dynamics).
- *Long Island Sound Integrated Coastal Observing System:* http://lisicos.uconn.edu/ (contains observation/forecast information for ocean dynamics with an emphasis on LIS).
- *Stevens Institute of Technology Urban Observatory* : http://hudson.dl.stevens-tech.edu/maritimeforecast/ (contains observation/forecast information for ocean dynamics with an emphasis on LIS)
- *National Oceanic and Atmospheric Administration (NOAA) Digital Coast:* http://www.csc.noaa.gov/digitalcoast/data (clearinghouse of coastal environmental data, including economics data and digital nautical charts).
- *Columbia/Lamont-Doherty Earth Observatory GeoMapApp:* http://www.geomapapp.org/
- *NOAA - Environmental Sensitivity Index (ESI) Maps:* http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html
- *Marine Cadastre:* http://www.marinecadastre.gov/default.aspx (website that allows the user to view and download datasets created by NOAA Coastal Services Center in cooperation with, and funded by, the Bureau of Ocean Energy Management [BOEM])
- *New York Ocean and Great Lakes Data Portal and Atlas:* http://portal.ny.stone-env.net/geoportal/catalog/main/home.page (site with social, economic, and environmental information)
- *NYSDEC Geodata Inventory:* http://www.dec.ny.gov/pubs/212.html
- *NYS GIS Clearinghouse:* http://gis.ny.gov/
    - Direct link to the datasets available for Suffolk County: http://gis.ny.gov/gisdata/inventories/results.cfm?SWIS=47
- *New York, Suffolk County Aquaculture Lease Program:* http://gis2.suffolkcountyny.gov/shellfish/
    - Other county data is at: http://gis.co.suffolk.ny.us/imaphome/index.html
- *GIS websites of local communities on Long Island:* The four federally-approved Local Waterfront Revitalization Program (LWRP) communities that would have jurisdiction are The Village of Sag Harbor, The Town of Southold, the Village of Greenport, and the Town of East Hampton. The non-LWRP/non-federally approved communities with jurisdiction are the Town of Southampton, Town of Riverhead, Town of Shelter Island, and potentially the Town of Brookhaven. (Note: These communities have not yet been contacted, but this will be considered in future, more in-depth searches for the preparation

of the ELIS SEIS, as appropriate. Jennifer Street, NYSDOS, provided contact information for each of these communities.)

- *Rhode Island Geographic Information System (RIGIS):* www.edc.uri.edu/rigis/
- *Rhode Island Marine Data:* http://www.narrbay.org/physical_data.htm
- *Rhode Island Ocean Special Area Management Plan (RI SAMP; 2010):* http://www.crmc.ri.gov/samp_ocean.html or http:www.seagrant.gso.uri.edu/oceansamp/.

2.2.5 Physical Oceanographic Literature Search and Data Gap Analysis

A separate literature search and data gap assessment was performed by UCONN for physical oceanography of the ZSF. This stand-alone report is attached as Appendix C.

2.3 Integration of Data into GIS Layers

Spatial information available in GIS format was compiled to assist in the screening of potential alternative dredged material disposal sites. Some of the screening information was initially obtained by Battelle (2013), and compiled and/or modified, herein, as appropriate. Relevant GIS maps are included in Section 3 below; metadata information is as follows:

- **Bathymetry:** Bathymetric data were obtained from DAMOSVision and were prepared in 2012 from then up-to-date NOAA-National Ocean Service (NOS) data (personal communication, Drew Carey, DAMOSVision, June 3, 2013). In addition, detailed bathymetry was obtained from multibeam bathymetric surveys conducted by NOAA and the USGS within the ZSF over the last decade.
- **Sediment Texture:** Sediment texture data were obtained from the USGS, Woods Hole, MA. The sediment data for the browse map was released in USGS Open-File Report 98-502 available at: http://pubs.usgs.gov/of/1998/of98-502/fpage.htm (delimited text and Excel files of the data are downloadable from Chapter 3). This dataset contains USGS data up to 1998, as well as other sources such as NOAA's NOS, USACE, and academic sources. The polygon layer was published in Poppe et al. (2000a); this layer was released in Open-File Report 00-304 as a compressed shapefile, available at: http://pubs.usgs.gov/of/2000/of00-304/. A second sediment texture database was accessed from USGS Open-File Report 2005-1001 (Poppe et al., 2005).

  More recent USGS data are also available in the USGS Woods Hole GIS database. Current data extend to 2010. The database is planned to be updated in 2014 (Larry Poppe, USGS, personal communication, August 22, 2013).
- **Maximum Tidal Bottom Stress:** Preliminary data were provided by UCONN based on modeling efforts.

- **Cables and Pipelines:**

  Cable and Pipeline areas (1): Available data on cable and pipeline locations were downloaded from the Northeast Ocean Data Portal. Submarine cable data was also obtained from the Department of Commerce, NOAA NOS, Coastal Services Center.

  Cable and Pipeline areas (2): NOAA Raster Navigational Charts (RNCs) were downloaded from www.charts.NOAA.gov/RNCs/RNCs.shtml on August 5, 2011. Each chart at the 1:40,000 to 1:20, 000 scale range was examined, with some additional charts examined at 1:15,000 for specific locations. The RNCs were examined to identify and digitize pipeline areas in ArcGIS. Digitization occurred at scales ranging from 1:12,000 to 1:4,000. The submarine cable areas dataset APPROACH_HARBOR_CBLARE_poly from NOAA Electronic Navigational Charts (ENC) Direct to GIS was downloaded for the northeast region using the bounding coordinates North: 44, South: 37, East: -65, and West -74. Where existing cable area features from the ENC Direct to GIS dataset corresponded to pipeline areas, that feature was copied into the new pipeline areas dataset.

- **Fishing Areas:** GIS data were obtained from the Rhode Island GIS website (RIGIS) and are dated 2009 . The data consist of GIS layers depicting recreational fisheries and commercial fisheries as mobile or fixed. Also available on Rhode Island SAMP website (http://www.crmc.ri.gov/samp_ocean.html).

- **Shellfish Bed Locations:**

  Connecticut: Shellfish bed locations were downloaded from http://www.ct.gov/. The information d epicts the approximate location of shellfish beds (hard clam, soft-shelled clam, and oysters) along the Connecticut coast, and was published in 1997. Additional more current data may be available from the Connecticut Department of Agriculture.

  New York: Data were obtained from the Suffolk County Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay. Published in 2007, the information depicts shellfish cultivation zones as well as sediment grain size information. Shellfish b eds within the shoal areas on the north shore of Long Island were digitized from the NYSDEC 2003 surf clam assessment.

  Rhode Island: Data were obtained from the Rhode Island Department of Environmental Management (RIDEM), Division of Fish and Wildlife, Coastal Fisheries Lab; publication date 1994.

- **Commercial Vessel Traffic Density:** Data from the U.S. Coast Guard Nationwide Automatic Identification System (AIS) database were obtained from the Northeast Ocean Data Portal. A density grid was created using track lines generated from the 2009 AIS database. Vessel track lines were created separately for each month, along with a unique density grid per month. These grids were then summed together. The source AIS data is missing from June 5th through June 30th, 2009; it should be noted that the data grids represent only 339 days in 2009.

- **Recreational Vessel Traffic Density:** The Northeast Recreational Boating Density Layer was obtained from the Northeast Ocean Data Portal. This GIS layer was created from the results of the 2012 Northeast Recreational Boater Survey conducted by SeaPlan and the Northeast Regional Ocean Council (NROC), in partnership with state coastal management programs and state marine trades associations in the Northeast.

- **Conservation areas:** In addition to the websites listed in Section 2.2.4 above, the following sites was accessed:

  Deep Sea Coral National Observation Database : Data were obtained from the Northeast Region (NOAA 2012) New York Biogeography Assessment, via mapping service (http://egisws02.nos.noaa.gov/ArcGIS/services), National Database o f Deep Sea Coral Observations, Northeast version 1.0. This database was developed by the NOAA NOS National Centers for Coastal Ocean Science (NCCOS) Center for Coastal Monitoring and Assessment (CCMA) Biogeography office as part of a New York Offshore Spatial Planning project. The data were compiled from unconfirmed records of observations from historical sources. Absence of an observation should not be interpreted as absence of corals.

- **Shellfish Zoning:**

  Connecticut: The Shellfish Area Classification, downloaded from the CTDEEP website (http://www.ct.gov/) represents the classifications of shellfish growing areas.

  New York: Data were obtained from the Suffolk County Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay. Published in 2007, the information depicts shellfish cultivation zones. In addition, local shellfishing restrictions and 2013 Temporary Marine Area Use Assignments were obtained from NYSDEC.

  Rhode Island: Data were obtained from the Shellfish Harvest Prohibition Areas for 2011, RIGIS 2011.

- **Eelgrass Beds:**

  Connecticut and North Shore of Long Island: Information was obtained from the Connecticut Eelgrass Beds Survey 2009, CTDEEP (http://www.ct.gov/DEEP). The survey was created by the Conservation Management Institute of Virginia Tech University for the U.S Fish and Wildlife Service (USFWS) National Wetlands Inventory, Region 5, and distributed through the CTDEEP website. The project area encompassed the eastern end of ELIS. It included all coastal embayments and nearshore waters (*i.e.*, to a depth of -5 m [-15 feet] at mean low water) bordering Long Island Sound from Clinton Harbor in the west to the Rhode Island border in the east, and including Fishers Island and the North Shore of Long Island from Southold to Orient Point and Plum Island. The study area also included the tidal zone of the following 18 sub-basins in Connecticut: Little Narragansett Bay, Stonington Harbor, Quiamb aug Cove, Mystic Harbor, Palmer-West Cove, Mumford Cove, Paquonock River, New London Harbor, Goshen Cove, Jordan Cove, Niantic Bay, Rocky Neck State Park, Old Lyme Shores, Connecticut River, Willard Bay, Westbrook Harbor, Duck Island Roads, and Clinton Harbor.

Two additional layers from New York State (SAV_2000 and SigHAbs_SAVsubunit_acreage), were reviewed but were not found to contain data relevant to the study area.

Rhode Island: Information was obtained from the dataset titled Submerged Aquatic Vegetation (SAV) in Rhode Island Coastal Waters (2012), http://www.edc.uri.edu/rigis. Rhode Island's SAV dataset depicts eelgrass and other SAV, including widgeon grass. These data were developed by the Rhode Island Eelgrass Mapping Task Force and distributed through RIGIS.

- **Historic and Active Disposal Sites:** Information was provided by DAMOSVision, based on data available from the USACE (personal communication, Drew Carey, DAMOSVision, June 3, 2013).

- **Archaeological and Cultural Resources:** Information was gathered from NOAA's Automated Wreck and Obstruction Information System (AWOIS), http://www.nauticalcharts.noaa.gov/hsd/awois.html. AWOIS p rovides a historical record of selected wrecks and obstructions including a brief history and descriptive details. The emphasis is placed on wrecks, which may be a hazard to navigation, therefore this dataset may not be a complete record of all potential shipwrecks. This dataset is continuously updated.

- **Alternative Energy (offshore wind, wave, tidal):** Current GIS information was obtained from the U.S. Department of Energy.

- **Continental Shelf and Areas within 25 Nautical Miles of Dredging Centers:** Data were developed by Battelle from GIS layers prepared for the LIS DMMP program and criteria from site screening for the CLIS/WLIS EIS (USEPA and USACE, 2004a).

For reference purposes, GIS graphics prepared by Louis Berger in Section 3 below include the ZSF, state boundaries, and active and historic dredged material disposal sites.

3.0 DATA GAP ASSESSMENT

This section assesses Data Needs, Existing Information (identified during the literature search) , Potential Other Sources (that are expected to exist but were not investigated at this time), and Data Gaps (that identify data that will need to be obtained for each resource). The information is organized following the Table of Contents of Chapter 4 (Affected Environment) of the CLIS/WLIS EIS (USEPA and USACE, 2004 a), as the forthcoming ELIS SEIS is expected to incorporate a similar Table of Contents to allow for direct comparisons between the two EIS documents by reviewers. The data gap assessment considers the 5 general and 11 specific ocean disposal site criteria listed in MPRSA.

It is noted that identified data gaps in this report are based on the broad survey of available literature conducted to date. Some additional data gaps will likely be encountered during the SEIS preparation and will be addressed at that time.

3.1 Physical Location and Setting

Data Needs: Description of overall setting of ZSF and potential alternative disposal sites.

Existing Information: Adequate information for the overall setting of the ZSF is available from the CLIS/WLIS EIS (USEPA and USACE, 2004a), the RIR EIS (USEPA and USACE, 2004 b), the Broadwater LNG EIS (FERC, 2008), the Dredged Material Management Plan (DMMP) documents (USACE, 2013), and multiple publications by the USGS.

Potential Other Sources: Not applicable (n/a).

Data Gaps: None.

3.2 Bathymetry

Data Needs: Detailed bathymetric data for the entire ZSF for screening of alternative disposal sites, for the selection of field sampling stations, and for NEPA analyses of selected sites.

Existing Information: Bathymetric data are available from NOAA-NOS, assembled by DAMOSVision in 2012 from most recent data (personal communication, Drew Carey, June 3, 2013), and from the NOAA/USGS multibeam bathymetric surveys over the last decade (*e.g.*, Poppe et al., 2006). Multibeam data for ELIS (Figures 3 and 4) and the eastern part of BIS (Figures 5 and 6) have been processed.

A multibeam bathymetric survey has also been conducted in western BIS, but data have not yet been completely processed. The survey area abuts the ELIS survey area in the northwest, and the eastern BIS survey area in the east. The southern border of the survey area is located at approximately 41° 7.5'N, which corresponds to a line approximately halfway up Gardiners Island. The other boundaries of the survey area are as follows (approximate): north - 41° 11.8'N; west - 72° 06'W; east - 71° 51.3 'W (Larry Poppe, USGS, personal communication, June 5, 2013). Preliminary review of unpublished data suggests that the deep hole located to the south of the eastern end of Fishers Island Sound is at least in part an erosional feature, as reflected in the rip-up clasts of glacial sediments observed along its comparatively steep eastern slope.

The multibeam bathymetric survey contour coverage of the processed data is 2 m. As stated in Poppe et al. (2006), these multibeam data are suitable to (1) define the topographic variability of the sea floor, which is one of the primary controls of benthic habitat diversity; (2) improve the understanding of oceanographic processes controlling the distribution and transport of bottom sediments and the distribution of benthic habitats and associated infaunal community structures; and (3) provide a detailed framework for future research, monitoring, and management activities. The bathymetry for the ZSF, based on the most detailed available data, is presented in Figure 7.

Bathymetric information for all or part of the two active disposal sites has been obtained by the USACE through the DAMOS program. Surveys conducted over the last two decades consist of the following:

- *New London Disposal Site* (NLDS): 1997, 1998, 2000, 2002, 2003, 2006 (SAIC, 2001a, 2001b, 2000, 2002, 2003, 2006; AECOM, 2011)
- *Cornfield Shoals Disposal Site*: 1994, 2004 (SAIC, 1996; ENSR, 2005).

Potential Other Sources: The U.S. Navy may have additional bathymetric data in selected areas such as those surrounding New London, Fishers Island, and the anchorage area north of Montauk.

Data Gaps: None expected, with the possible exception of the areas north of Montauk and an area south of Clinton Harbor ; multibeam bathymetric data are not available for both of those areas.

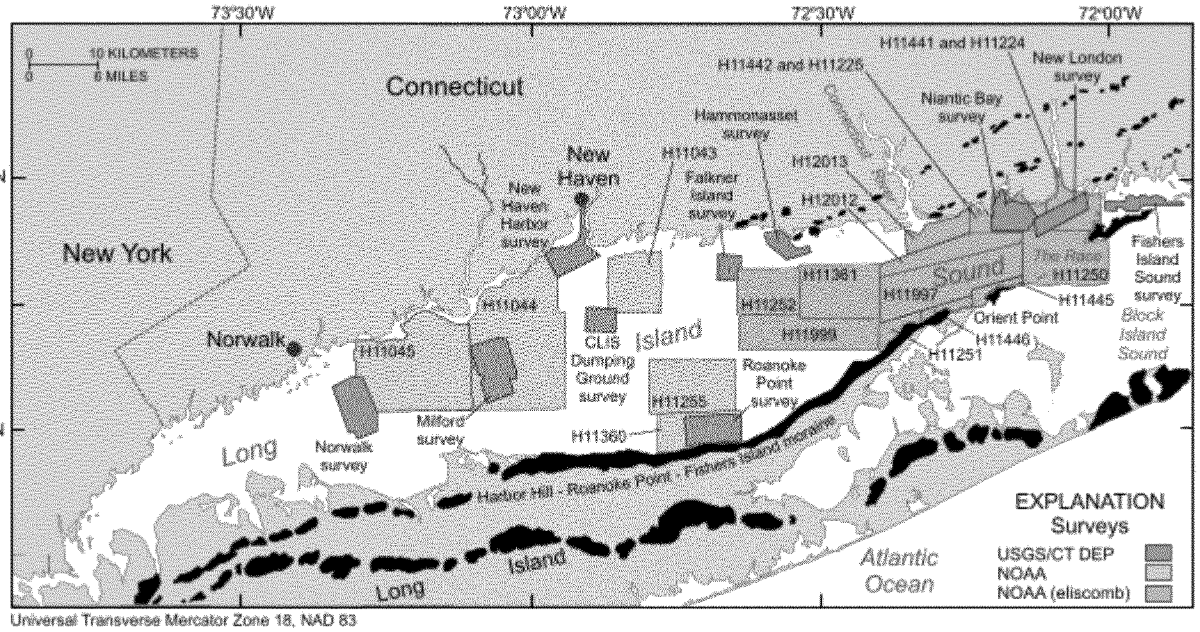


Figure 3. Location of the combined multibeam and Laser Interferometry Detection and Ranging (LIDAR) bathymetric dataset in LIS (USGS, 2011).

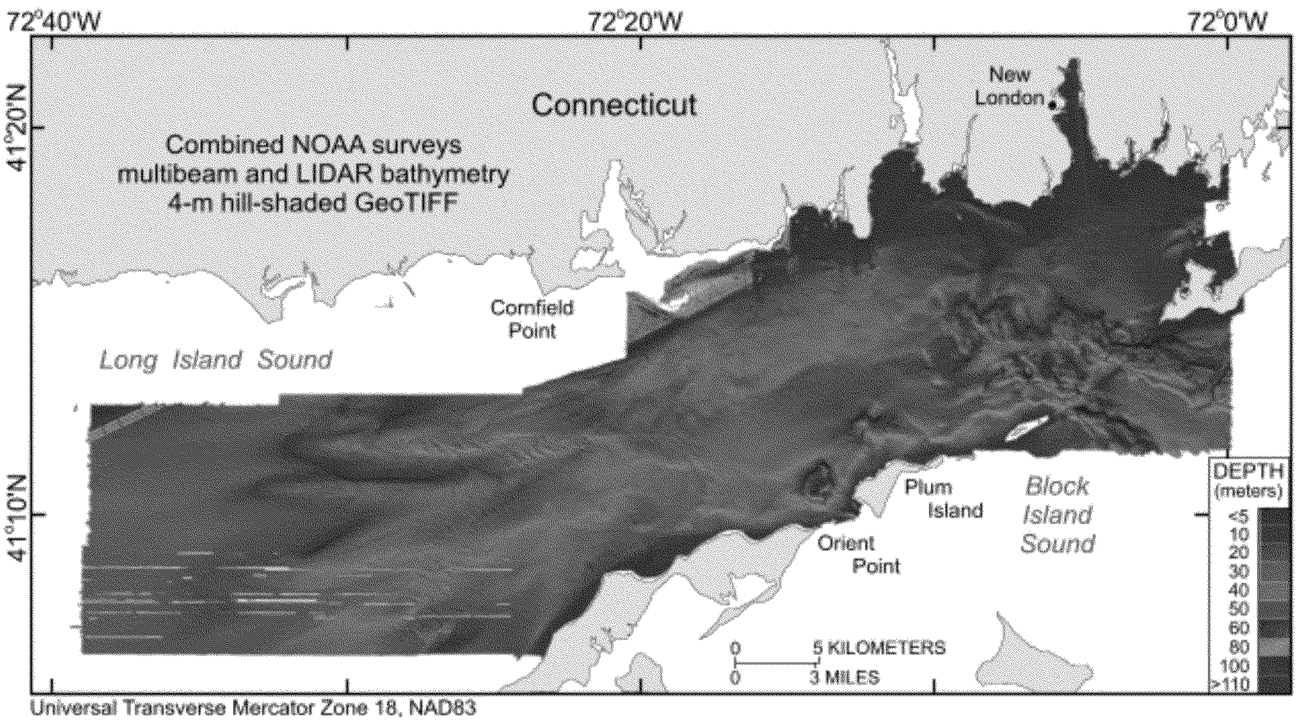


Figure 4. Digital terrain model of sea floor based on multibeam bathymetry (USGS, 2011).

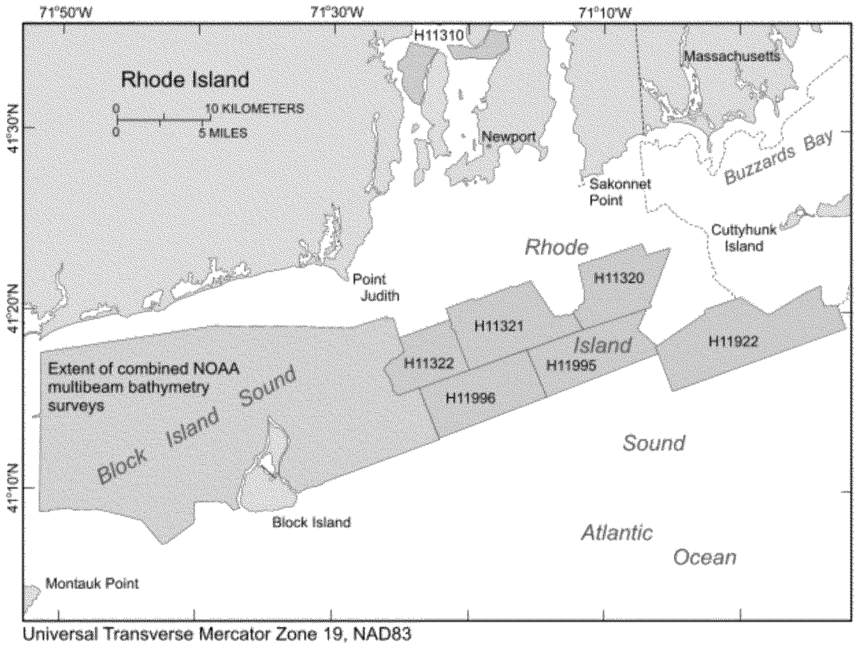


Figure 5 . Location of combined multibeam and LIDAR bathymetric datasets in BIS (USGS, 2012). Additional data are available for western BIS, but are still being processed.

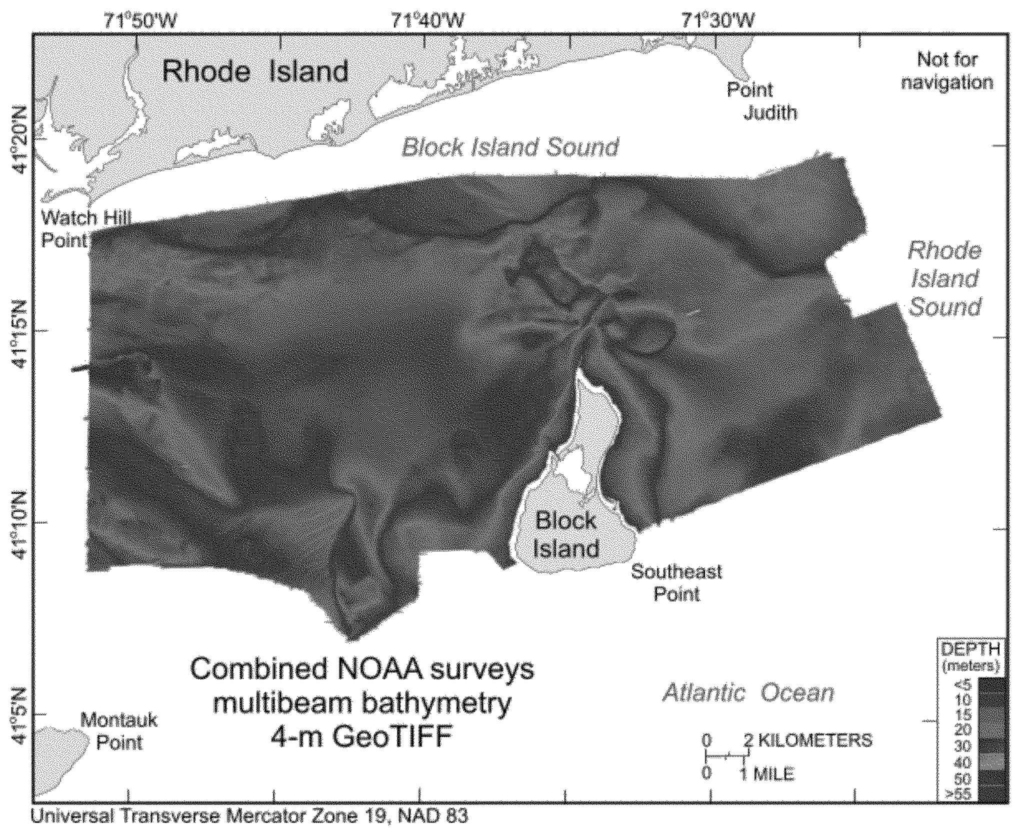


Figure 6 . Digital terrain model of sea floor based on multibeam bathymetry (USGS, 2012).

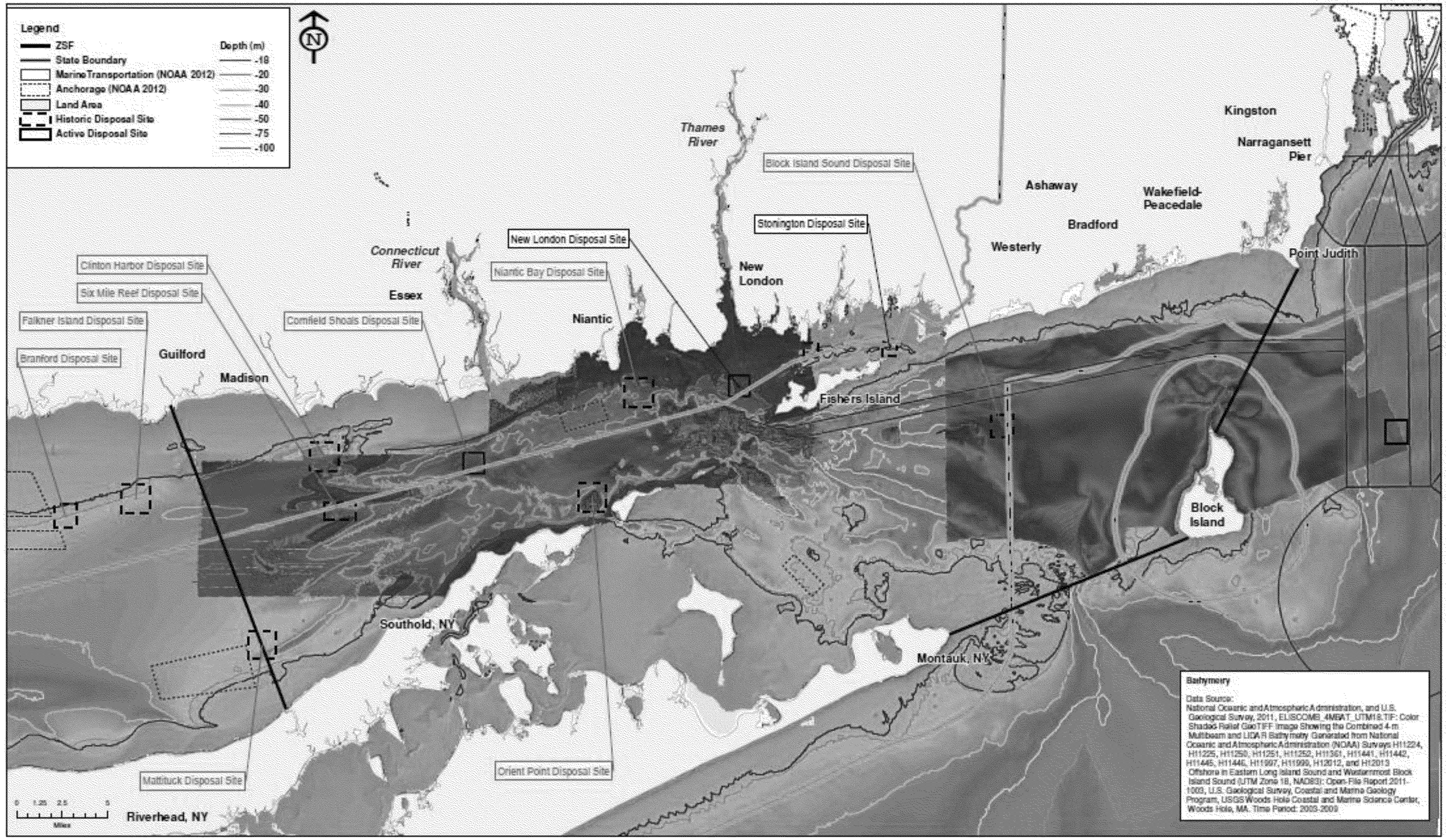


Figure 7. Bathymetry in the ZSF, combining NOAA bathymetric information with more detailed multibeam bathymetric data, where available (GIS compilation; July 17, 2013).

3.3 Geological Setting and Geomorphology

Data Needs: Data that describe the geological history of the area and pertaining to processes such as sedimentation, erosion, sediment transport, geomorphological features, etc. for the entire ZSF and for potential dredged material disposal sites.

Existing Information: Reports by the USGS, UCONN, and URI developed over the last 20 years are adequate for understanding the overall geologic setting of the ZSF. The NOAA/USGS multibeam bathymetric information allows for a detailed understanding of the geomorphology in most of the ZSF (as described in Section 3. 2 above). Poppe and Polloni (1998) conducted high - resolution sidescan surveys in the ELIS (Figure 8). Poppe et al. (2012b) reviewed the glaciotectonic history in the vicinity of The Race ' in the westernmost BIS using high-resolution seismic-reflection profiles, which contributes to the understanding of the recent geologic history of the area (Figure 9).

Needell and Lewis (1984) studied the stratigraphic framework and Quaternary geologic history of BIS using primarily high-resolution, seismic-reflection profiles (Figure 10). They observed that "d uring Holocene submergence the postglacial valleys were partly filled by fluvial, freshwater peat, estuarine, and salt-marsh peat deposits. Transgressing seas eroded and smoothed the sea floor. Marine sediments accumulated over the wave-cut surface. " (Refer to document abstract.)

Poppe et al. (2008) provided an overview of the geology and sedimentary processes in the vicinity of Six Mile Reef (Figures 1 1 and 12). The overview included a review of bedforms and sediment transport directions, observing that net bedload sediment transport is primarily to the west (this includes the area of the historic Six Mile Reef Disposal Site). An exception was observed at the western tip of the Six Mile Reef shoal, where the sand-wave morphology indicates long-term eastward transport (this includes the area of the historic Clinton Harbor Disposal Site).

Fenster et al. (1990), using bathymetric surveying techniques and in-situ submersible observations and measurements, observed that large bedforms are relatively stable over the short-term, and suggested that net migration rates of sand waves are affected by large residual flows created by high-energy, aperiodic storm events. The study area was located at the Cornfield Shoals Disposal Site, located about 2.8 km east of the study area by Poppe et al. (2008). Fenster prepared his dissertation in 1995. Fenster et al. (2006) observed that after 16 years, giant sand waves had migrated annually on average by 2.1 m (6.9 feet) to the southwest.

Potential Other Sources: n/a

Data Gaps: None expected for the ZSF in general. For potential alternative disposal sites, more detailed information would be needed for the northern part of the Clinton Harbor Disposal Site and for the area north of Montauk, in case these sites are considered as potential alternative sites and need to be assessed in detail in the SEIS.

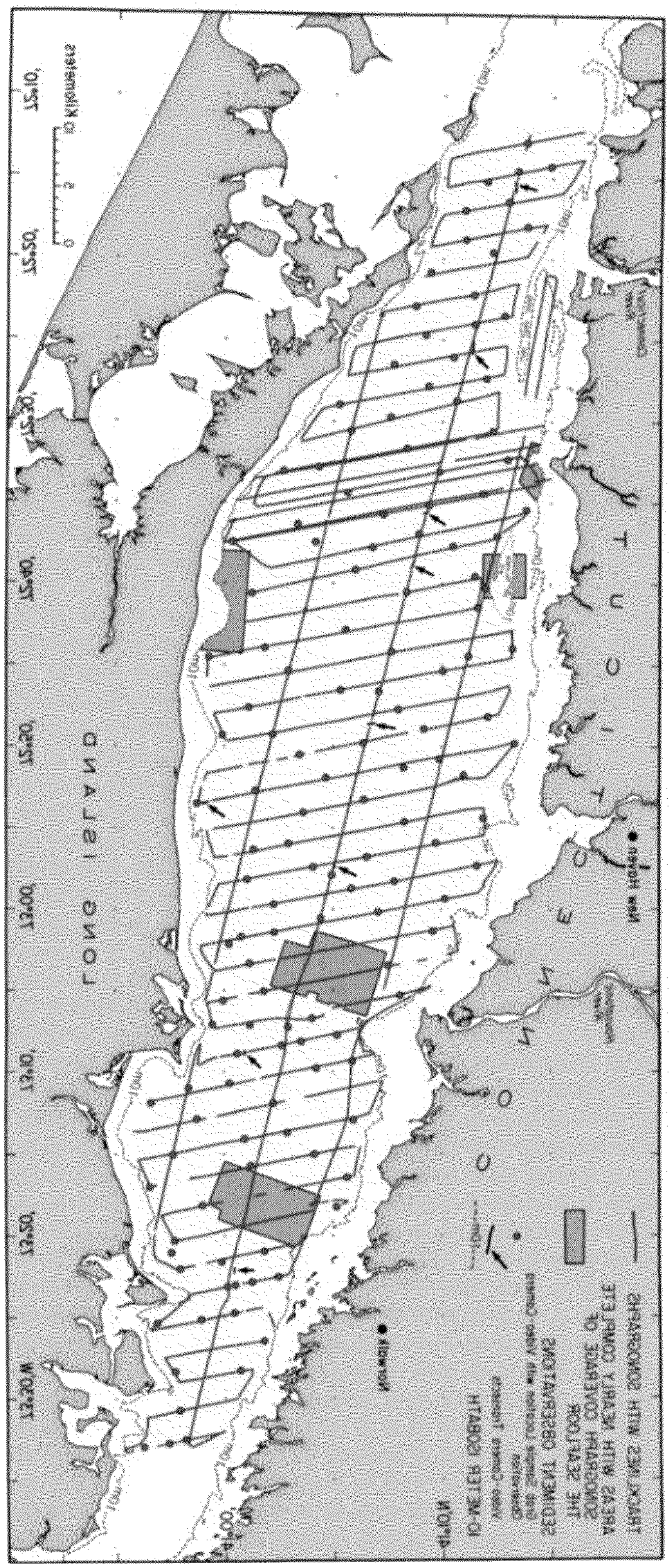


Figure 8. Locations of sidescan sonographs and supplemental sediment observations (Poppe and Polloni, 1998)

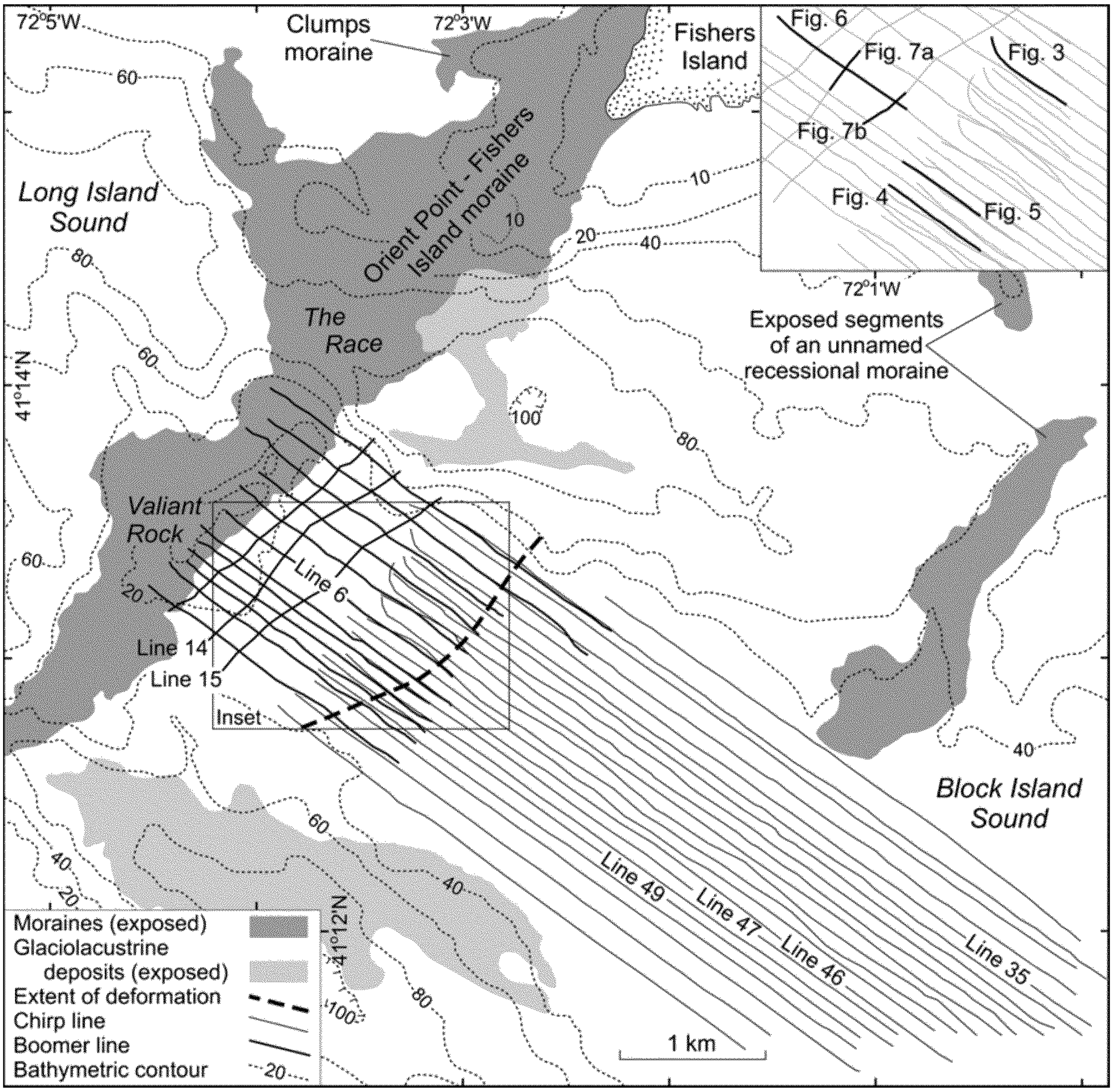


Figure 9. Study area of glaciotectonic history with track lines of seismic-reflection profiles collected in 2003 and 2010 in the vicinity of The Race (Poppe et al., 2012b). The area includes moraines, exposed glaciolacustrine deposits, scour depressions, and the i ce-distal extent of glaciotectonic deformation. Bathymetric contours are in meters.

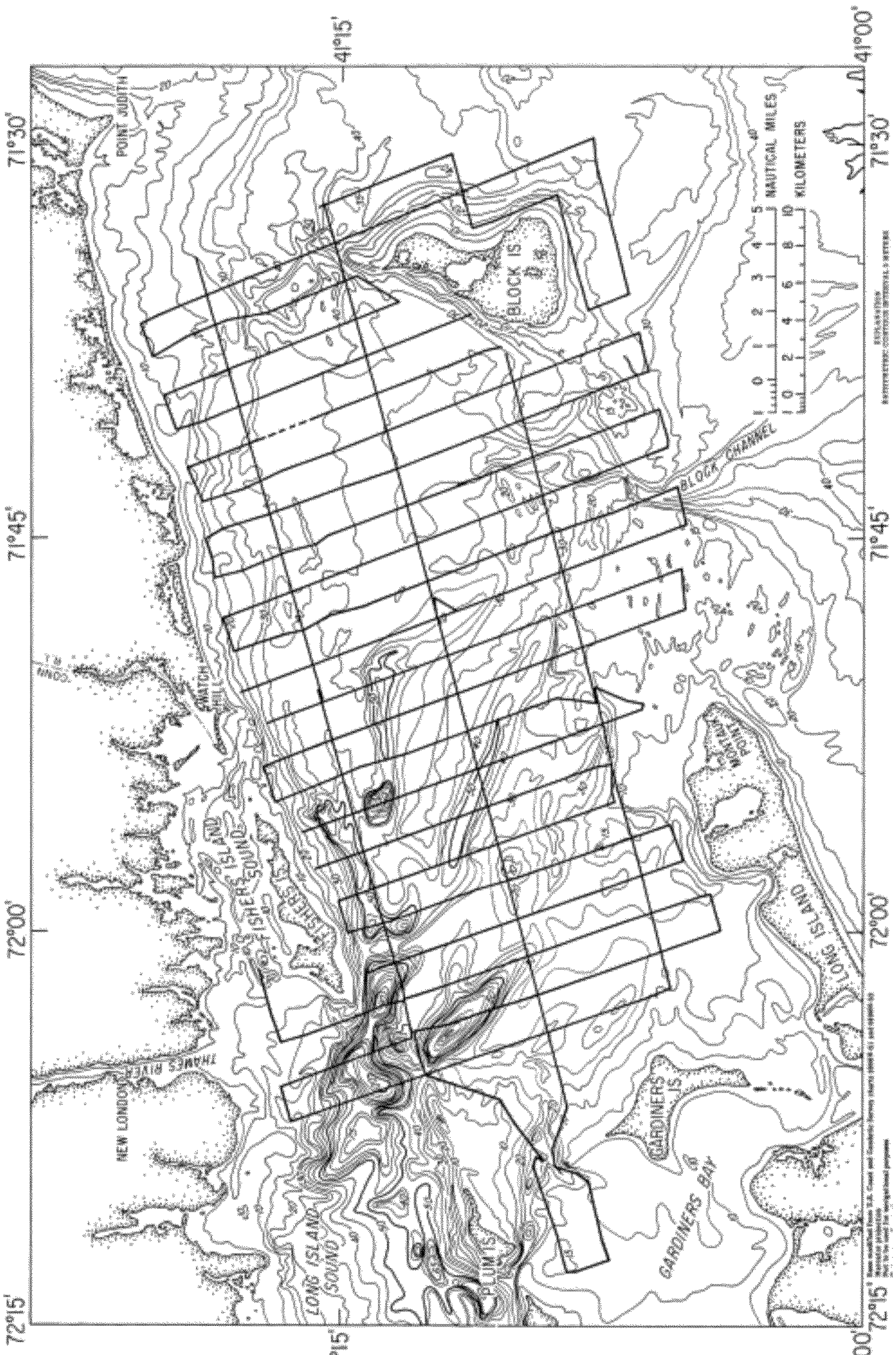


Figure 10. Sea floor topography and high-resolution subbottom profiles in BIS (Needell and Lewis, 1984).

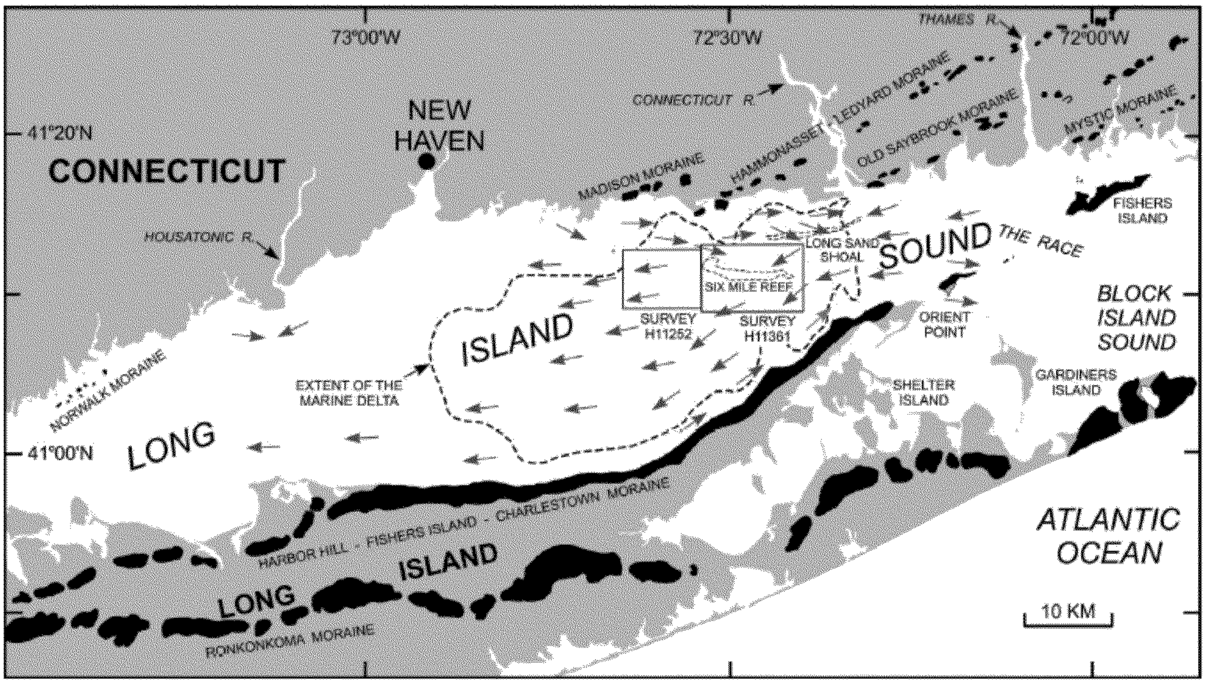


Figure 11. Study area around Six Mile Reef (Poppe et al., 2008). Net bottom sediment transport directions are indicated by gray arrows.

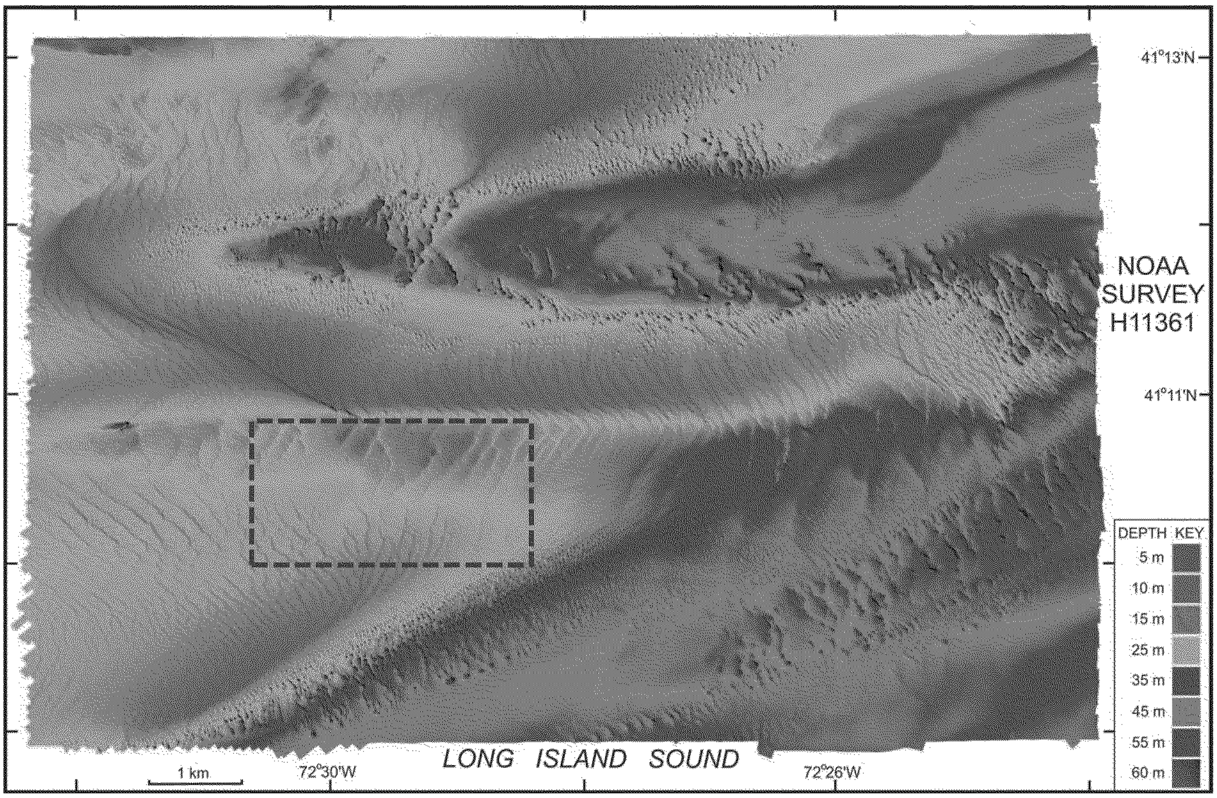


Figure 12. Digital terrain model of the seafloor around Six Mile Reef (Poppe et al., 2008). The approximate location of the historic Six Mile Reef Disposal Site is marked (dashed line).

3.4 Meteorology

Data Needs: Meteorological data to inform the hydrodynamic and sediment transport modeling, as well as to provide information regarding dredging windows and weather-related risks during transportation of dredged material.

Existing Information: Meteorological information is provided in the CLIS/WLIS EIS and the RIR EIS. Additional data from multiple sources are available from UCONN. A table with available meteorological data is provided in Appendix C.

Potential Other Sources: n/a

Data Gaps: None.

3.5 Physical Oceanography

Data Needs: Physical oceanographic data (waves, currents, bottom shear stress) to assess sediment transport (a) during dredged material disposal and (b) as a result of resuspension during storms or as a result of strong tidal currents.

Existing Information: UCONN reviewed recent documents and searched data distribution centers pertinent to the characterization of the physical oceanography of the ZSF (Appendix C). This review did not locate any reports with adequate measurements of wave characteristics or bottom stress in the ZSF. Existing bottom stress information in the ZSF is based on model results only and is therefore preliminary (Figure 13). Several sources with current profile measurements were identified; however, they were concentrated in either ELIS or B IS. Observations of the salinity and temperature distributions in the ZSF were sparse, though to the east and the west of the ZSF the data density increased. Measurements of wind speeds and river discharges appear to be adequate.

Morton et al. (1975) examined resuspension from dredged material disposal at the NLDS, and observed no major change in the shape or area of the disposal mound, after an initial stabilization period following disposal. Morton et al. (1975) also studied the bathymetry and bottom velocities (using deployed current meters) of the eastern deep hole south of Fishers Island Sound. Their measurements and other observations will be compared to findings of the ongoing physical oceanographic study. The authors also stated that the "elongated shape of the depression and its relationship to other features in BIS" support the contention by Savard (1966) that the deep hole located to the south of the eastern end of Fishers Island "is part of a submerged drainage pattern developed during periods of low sea level" (p. 10).

Potential Other Sources: n/a

Data Gaps: Due to limited existing data, there is a need for a program to determine the structure of the circulation, wave field, and the bottom stress distribution throughout the ZSF.

ED_001437D_00000426-00041

A physical oceanography study has been designed for 2013 and is currently underway. The study includes a field data collection component and numerical mod eling designed to adequately address the following issues:

- *Dredged material disposal plume:* Modeling using the University of Massachusetts-Dartmouth's Finite Volume Coastal Ocean Model (FVCOM) and USACE's Short Term Fate (`) models is planned to be conducted to simulate the evolution of a dredged material disposal plume following the release of sediments into the water column. This will include the effects of physical mixing, transport, settling and contaminant dilution during the first few hours after the release of dredged material from a barge.
- *Potential resuspension of dredged material:* The forces acting on the bottom sediment (*i.e.*, bottom stress) that could result in resuspension and transport of sediment are planned to be modeled using FVCOM and USACE's Long Term Fate (LTFATE) models . Variables will include hydrodynamic forces (wind, waves, currents), roughness of the sediment surface, and sediment cohesion. Resuspension will be modeled for normal conditions (average tidal current and wave energies) and extreme event conditions (*e.g.*, 100-year Nor'easters and hurricanes).

For both types of sediment transport events, the sediment plume during disposal and the resuspended sediment following extreme events, the path of the sediment in the water column will be evaluated, *i.e.*, transport direction and distance before particles settle out of the water column and are redeposited back onto the sediment surface. This information will then be used to assess impacts on natural resources in the water column and in the areas of redeposited sediment.

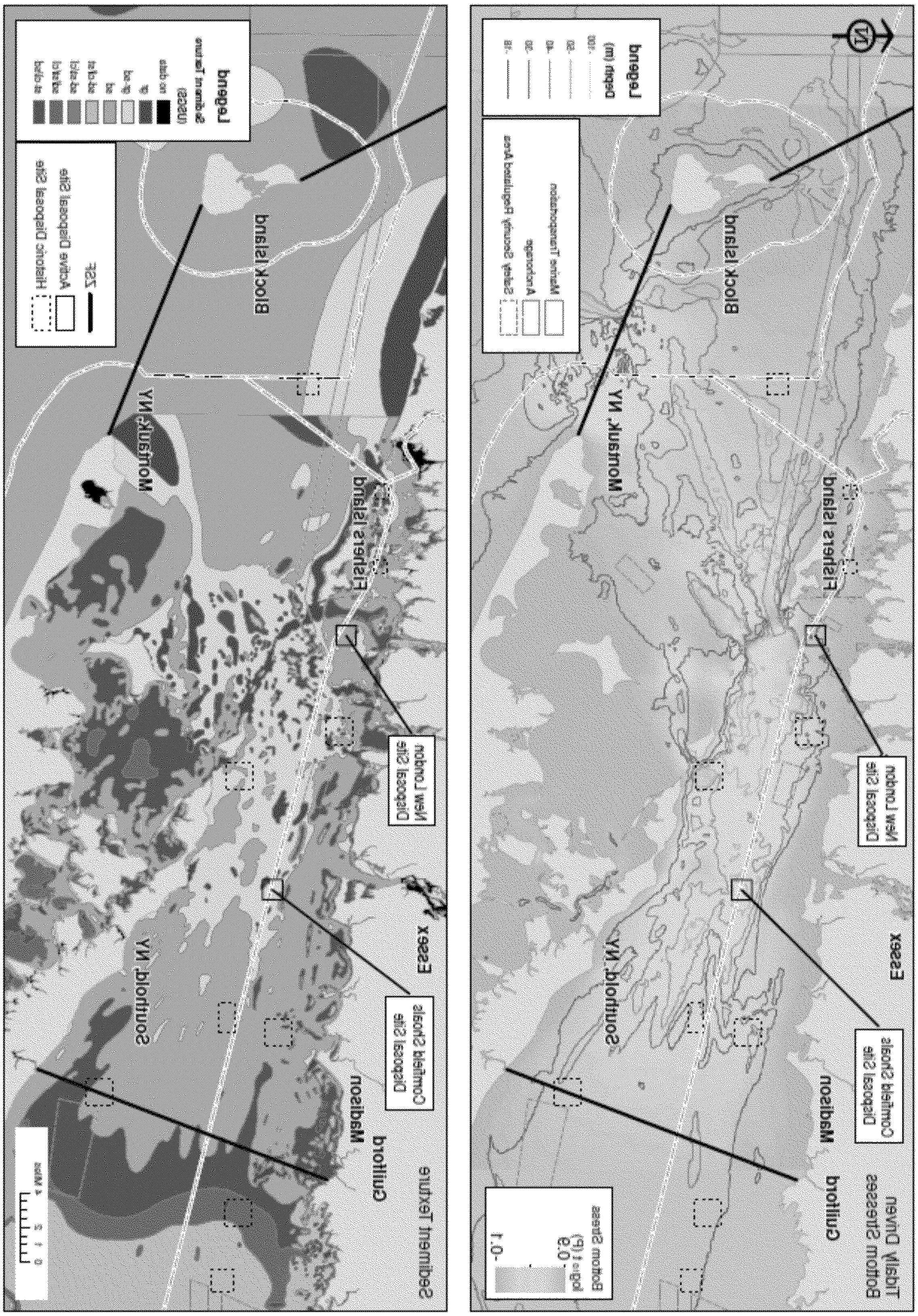


Figure 13. Bottom stress (left) and sediment texture (right) in the ZSF (GIS compilation; May 19, 2013)

ED_001437D_00000426-00043

3.6 Sediment Quality

Fifteen documents in WHG (2010) included sediment as a primary topic (Appendix A). In general, the documents covered bottom morphology, physical characteristics, and sediment contamination for small areas within ELIS. The discussion of sediment quality below is separated by parameter (grain size, total organic carbon, metals, and organic compounds).

3.6.1 Grain size

Data Needs: Sediment grain size provides information relevant for the understanding of sediment transport potential, benthic habitat, and sediment toxicity.

Existing Information: Figure 13 shows sediment data mapped by the USGS based on samples from multiple sources up to 1998 (Poppe et al., 2000a; see Section 2.3 for further details). Th is sediment texture map was interpolated from individual surface grab samples; thus the resolution is a function of the density of actual samples collected in any given area. Figure 14 presents a close-up of this map for ELIS ; in addition, it includes surface sediment samples from the USGS database up to 2005 (McMullen et al., 2005).

The most recent GIS database at the USGS has been updated with data collected through 2010 (Larry Poppe, personal communication, August 22, 2013). Additional sediment texture data from 2012 are available for the eastern BIS (Poppe et al., 2012a ; Figure 15). The finest-grained sediments were found in an area west of Block Island; sediments consisted of silty sand and contained worm tubes . This area was considered a "depositional environment" by the authors (Figure 16). For western BIS, USGS sediment data are also available, but not expected to be published until the summer of 2014 (Larry Poppe, USGS, personal communication, June 5, 2013).

Savard (1966) collected 84 surficial sediment samples in BIS as part of a Master's thesis at URI (Figure 17). Maps of the distribution of sediment types, as well as the silt and clay fractions, are presented in Figures 1 8 to 20. The depositional area of silty sand approximately coincides with the area shown by Poppe et al. (2012a; Figure 16).

A sediment grain size data compilation for BIS was provided in Poppe et el. (2003; Figure 21). The compilation includes data collected by the USGS as well as multiple other agencies and university researchers (including Savard [1966]). The data density is particularly high around Montauk. A dditional sediment texture data for active dredged material disposal sites are available through the USACE's DAMOS program (see references listed in Section 3.2).

Potential Other Sources: Selected grain size information may also be available from the universities (*e.g.*, The State University of New York [SUNY] Stony Brook, Yale University) but is likely limited in spatial extent.

Data Gaps: Sediment grain size information is considered adequate for characterizing the sediment texture within the ZSF. Additional grain size data would be needed for characterizing alternative disposal sites, preferably in conjunction with appropriate benthic and geochemical analyses.

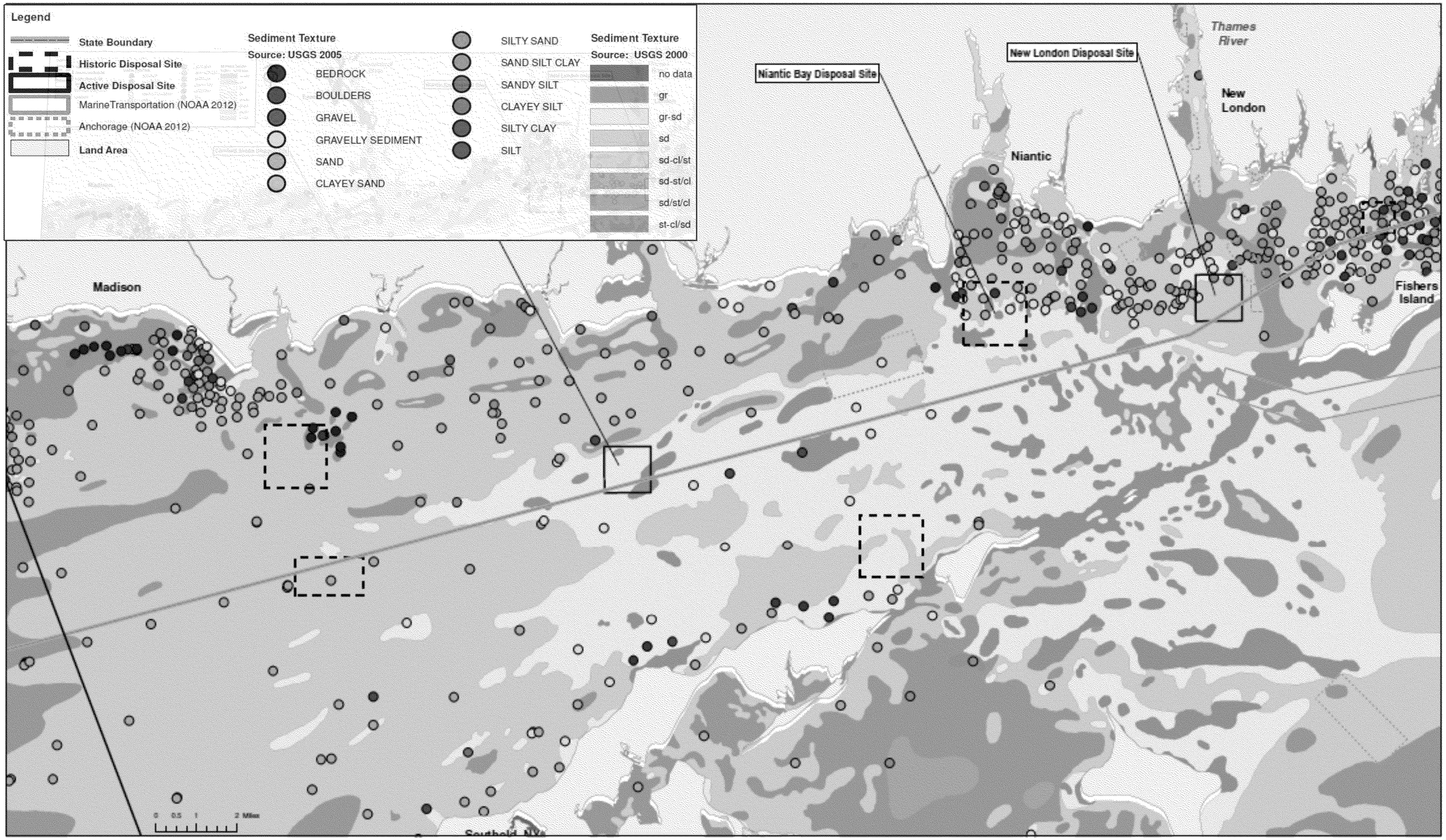


Figure 14. Closeup of sediment texture in ELIS, based on data mapped by the USGS from multiple sources up to 1998 (Poppe et al, 2000a) and data in the USGS database up to 2005 (circles; McMullen et al., 2005). (GIS compilation; May 19, 2013).

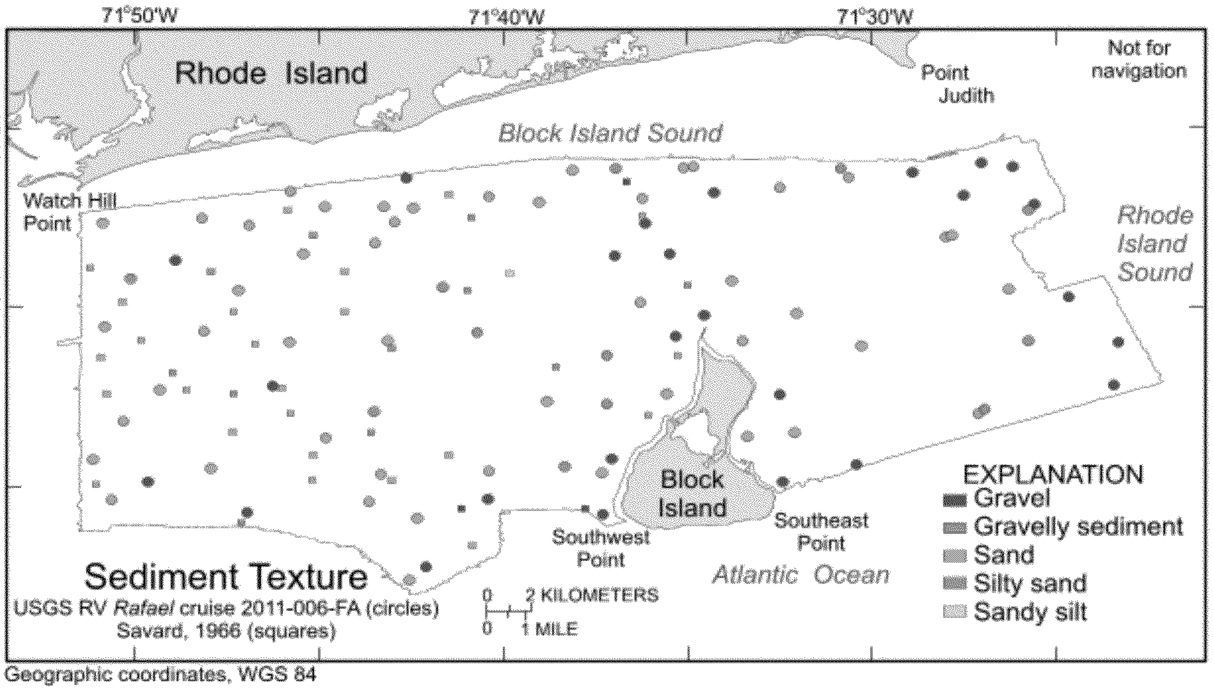


Figure 15. Sediment grain size in the eastern BIS (Poppe et al., 2012a).

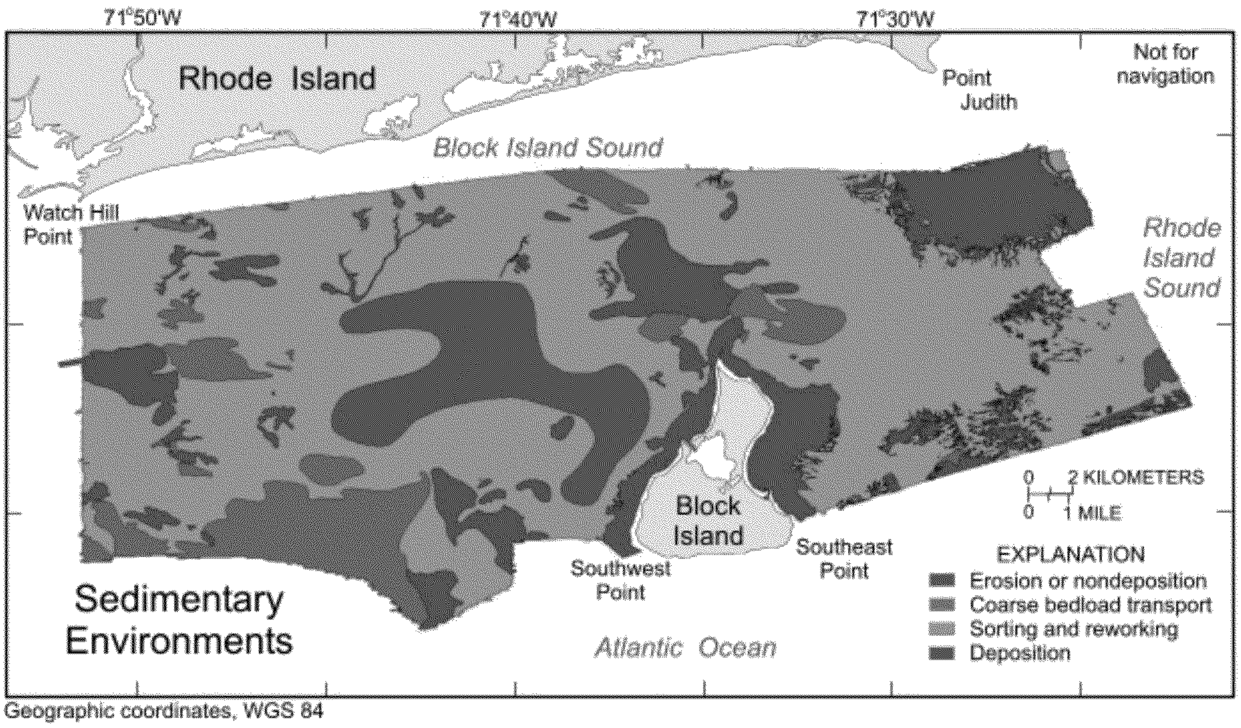


Figure 16. Sedimentary environments in the eastern BIS (Poppe et al., 2012a).

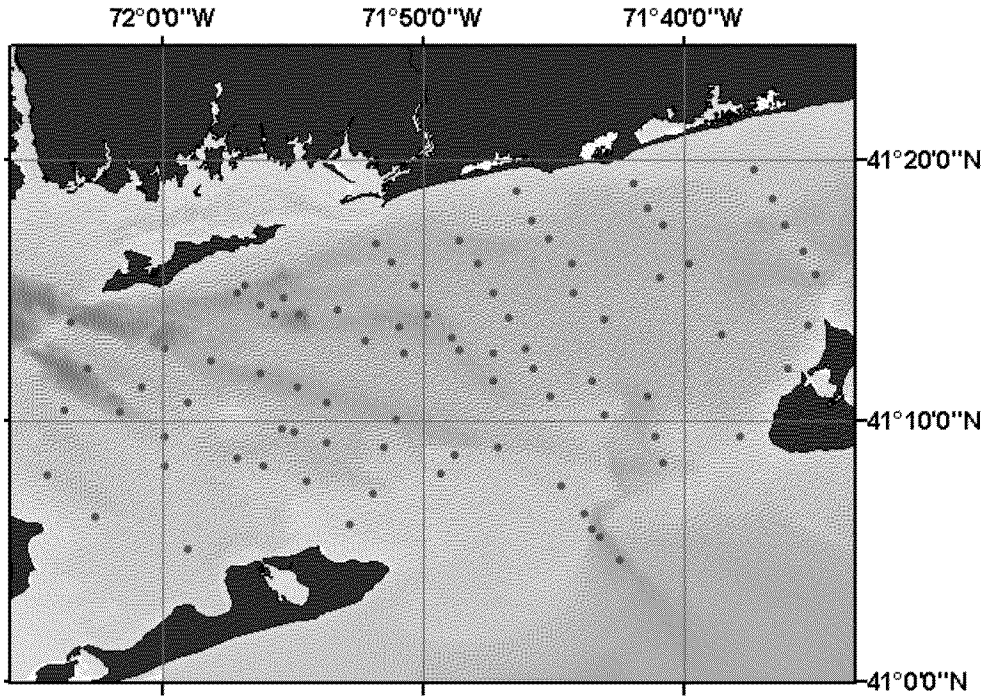


Figure 17. Surface sediment samples collected by Savard (1966) in BIS (map published in Poppe et al., 2003).

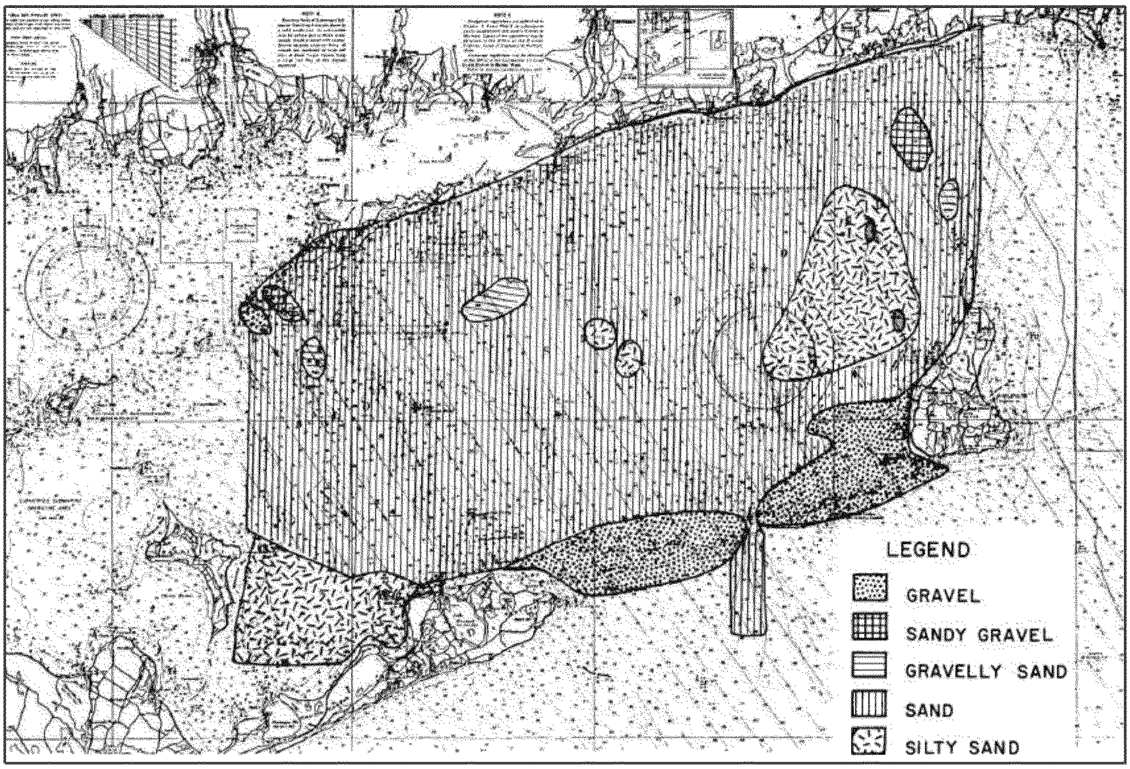


Figure 18. Sediment distribution in BIS (Savard, 1966, as published in U.S. Navy, 1973).

ED_001437D_00000426-00048

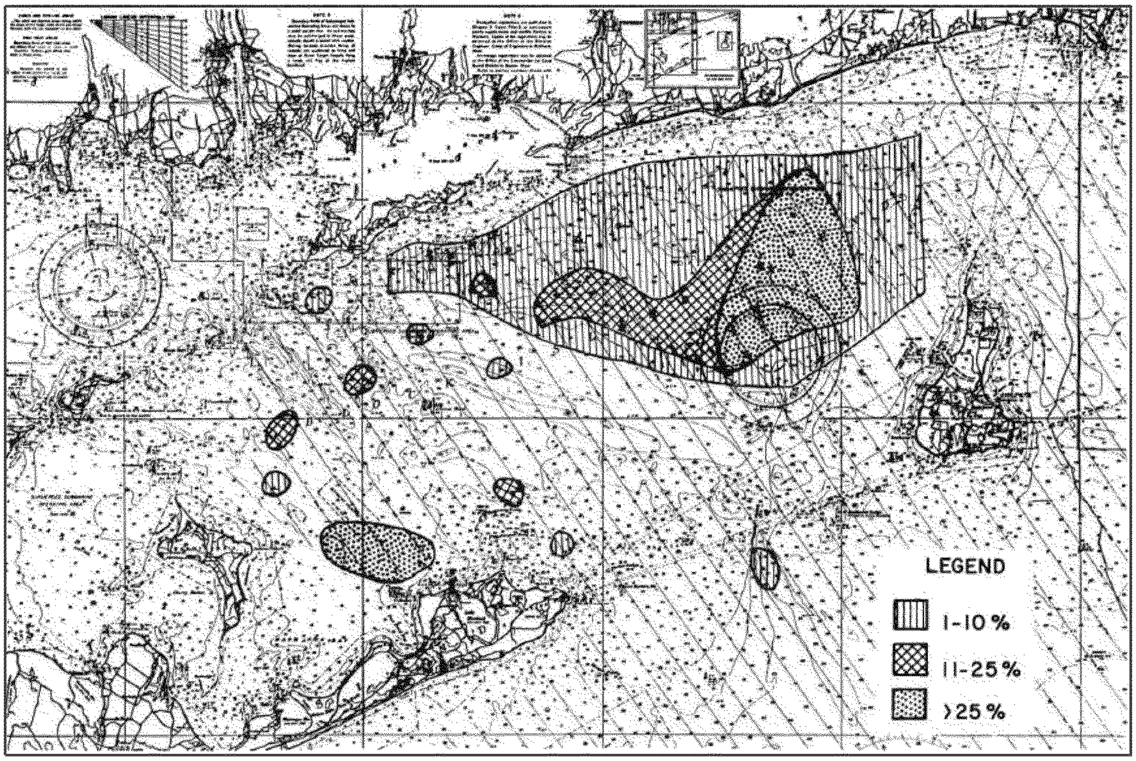


Figure 19. Distribution of silt in BIS (Savard, 1966, as published in U.S. Navy, 1973).

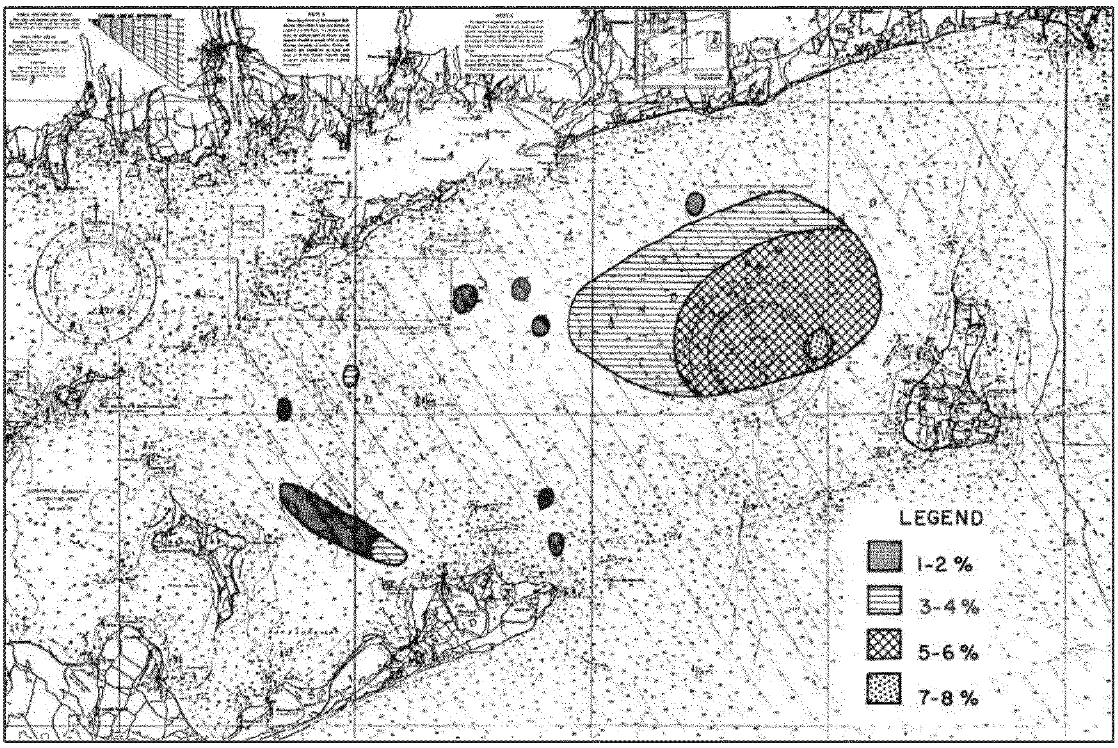


Figure 20. Distribution of clay in BIS (Savard, 1966, as published in U.S. Navy, 1973).

ED_001437D_00000426-00049

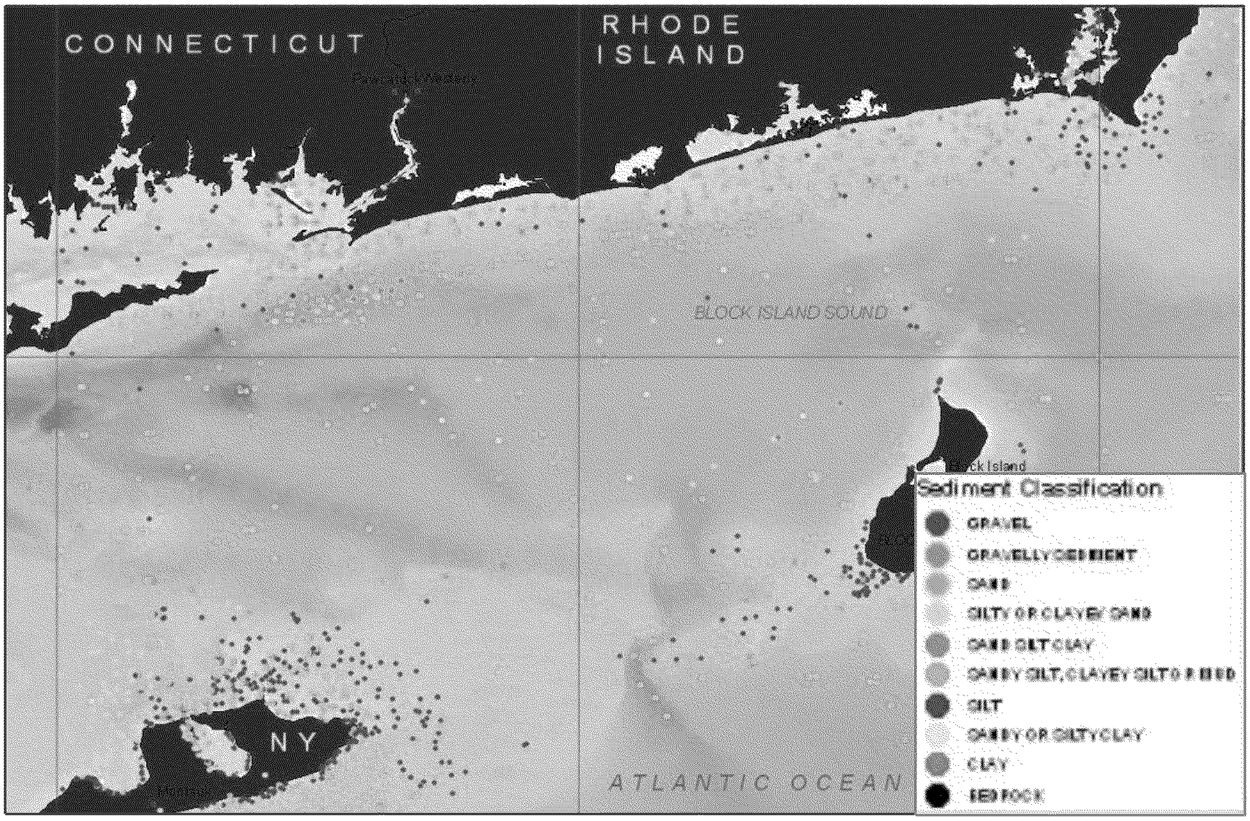


Figure 21. Compilation of sediment grain size data for BIS (Poppe et al., 2003), including the samples collected by Savard (1966).

ED_001437D_00000426-00050

3.6.2 Total Organic Carbon

Data Needs: Spatial distribution of total organic carbon (TOC) throughout the ZSF, and at potential alternative disposal sites.

Existing Information: TOC concentrations in surface sediments were measured in LIS by Poppe et al. (2000a), which included the western part of the ELIS (Figure 22). Anthropogenic contaminant concentrations were observed to correlate with the sedimentary environments, sediment texture, as well as with TOC (Figure 23). Hunt (1979) also observed that TOC concentrations and grain size of LIS sediments were highly correlated.

Potential Other Sources: Aside from the USGS, selected data for TOC in sediments of the ZSF may also be available from UCONN, URI, and SUNY Stony Brook, as well as from CTDEEP, NYSDOS, and RICRMC, but are likely limited in spatial extent.

Data Gaps: TOC data are adequate for general characterization of the ZSF. TOC should be analyzed for all sediment samples collected for geochemical analyses during field work at potential alternative sites.

3.6.3 Metals (Ag, Cd, Cr, Cu, Hg, Ni, Pb, Zn)

Data Needs: Metals concentrations in surface sediments throughout the ZSF and at potential alternative disposal sites. In addition, information about major potential sources, both historic and present (*e.g.* , loading through Connecticut River, Thames River, stormwater runoff from urban coastal communities, deposited dredged material at active disposal sites) may be needed to address questions about the relationship between sources and detected concentrations in offshore sediments for the SEIS.

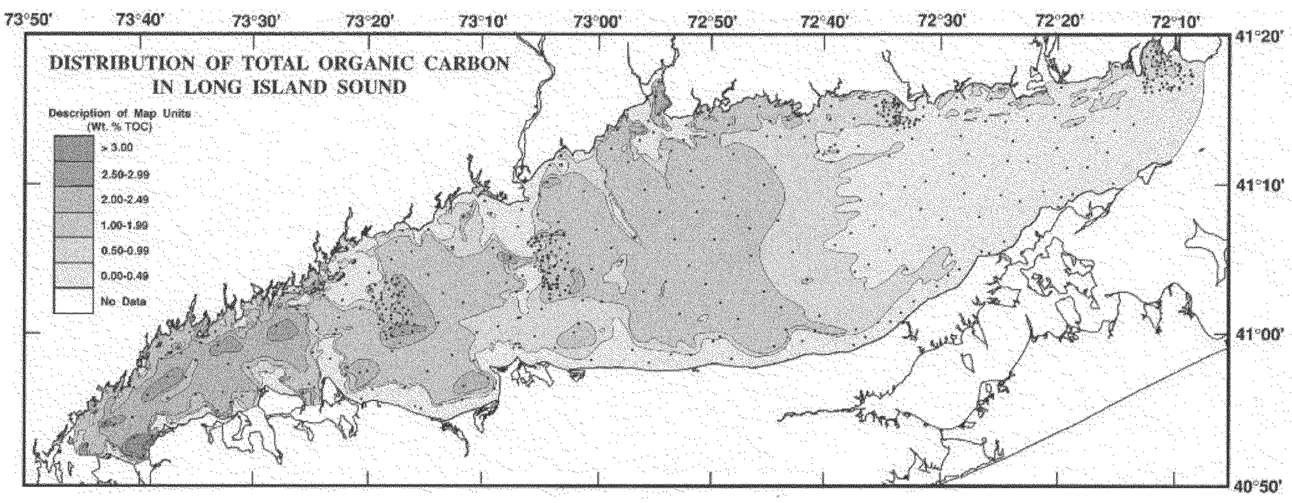


Figure 22. TOC concentrations in LIS (Poppe et al., 2000a).

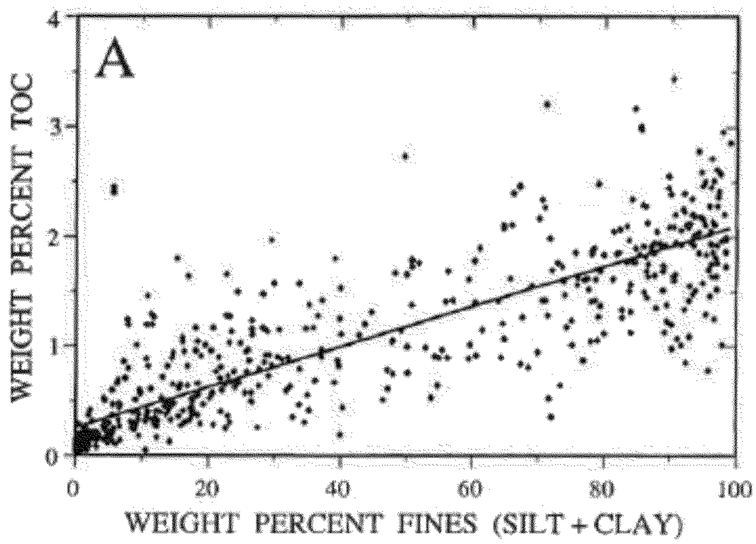


Figure 23. Relationship between TOC and grain size (Poppe et al., 2000a).

Existing Information: A study of metals concentrations in the surface sediments was conducted by the USGS throughout the LIS (Mecray et al., 2000; Mecray and Buchholtz ten Brink, 2000 ; Figures 24 and 25). Within the ZSF, it only includes the western part of the ELIS. Surface grab samples were analyzed for trace elements (Ag, Ba, Cd, Cr, Cu, Hg, Ni, Pb, V, Zn, and Zr) and major elements (Al, Fe, Mn, Ca, and Ti), grain size, and *Clostridium perfringens* spores. Mecray et al. (2003) also assembled a database with metals and other contaminant data for LIS and the New York Bight, which also includes data for BIS (Figure 26). The report provides maps of several of the contaminants in the database as well as references, and contains information collected between 1956 and 1997.

The WHG (2010) database lists several other references for individual metals such as mercury concentrations in cores in LIS, and in source waters (*e.g.*, Lamborg et al. , 2004). Mitch (2006) investigated the toxic contamination in LIS, compiling data on contaminant concentrations (metals, polychlorinated biphenyls [PCBs], pesticides, polyaromatic hydrocarbons [PAHs]) in the water column, sediments, and biota from existing studies and database s for the period 1994 through 2005; data sources included coastal and harbor samples.

The distribution of mercury in LIS was addressed by Varekamp et al. (2003) and Varekamp et al. (2000) based on data from the same stations; in the ELIS, only sediment samples from the upper surface 0-2 cm (0-1 inch) were analyzed.

Hunt (1979) collected surface sediment samples throughout LIS (Figure 27) for heavy metals analyses (Cd, Co, Cu, Ni, Pb, and Zn). G enerally, metals concentrations correlated to grain size and proximity to urban sources.

Since 1986, NOAA's National Status and Trends (NS&T) Program has monitored metals and organic compounds in surface sediments and blue mussels collected from coastal embayments as part of their Benthic Surveillance and Mussel Watch Programs. There are nine stations in LIS. Data are available at (http://egisws02.nos.noaa.gov/nsandt/index.html#), the NS&T data portal. NS&T program data were reviewed by O'Connor et al. (2006) and by Kimbrough et al. (2009).

Sediment coring and chemical analyses of the capped Seawolf Mound at the NLDS were conducted in 1997, 1998, 2001, 2006, and 2010 (SAIC, 2001a, 2004; AECOM, 2011, 2012). For example, the 2001 survey evaluated the physical and chemical composition of the deposited sediment and the benthic recolonization status of this mound relative to ambient conditions at reference areas. A total of 13 vibracores were obtained: 12 from the Seawolf Mound, and 1 collected at a reference area west of the mound (Figures 28 and 29). Sediments were analyzed for grain size, TOC, metals (As, Cd, Cr, Pb, Cu, Ni, Zn, Hg) and PAHs. Similarly, the 2010 survey collected 16 vibracores at nine stations at the mound (Figure 30), which were analyzed for TOC, PAHs, and grain size. Both studies found that the PAH concentrations of the sediments of the cap were consistent with pre-dredge characteristics.

Potential Other Sources: Metals data for the NLDS exist in older DAMOS reports. Some metals data may also be available through the work of other university researchers, but are expected to be limited in spatial extent.

Data Gaps: Metals data throughout BIS are limited, although concentrations are expected to be comparatively low due to the coarse sediment grain size and absence of major contaminant sources. Metals data in ELIS are considered adequate for an overview of metals concentrations in the ZSF, but are insufficient for the characterization of potential alternative disposal sites.

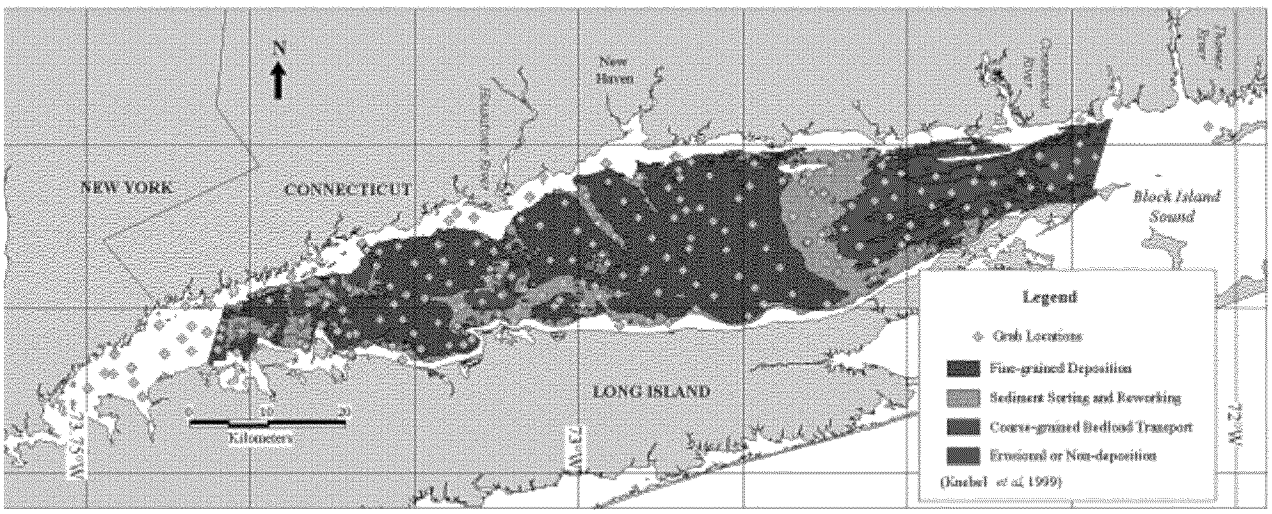


Figure 24. Locations of surface sediment samples taken on three cruises to LIS (Mecray et al., 2000). Stations were selected to sample the different sedimentary environments, sediment types, and proximity to potential metals sources in LIS. Sedimentary environments from Knebel et al. (1999) are superimposed.

ED_001437D_00000426-00053

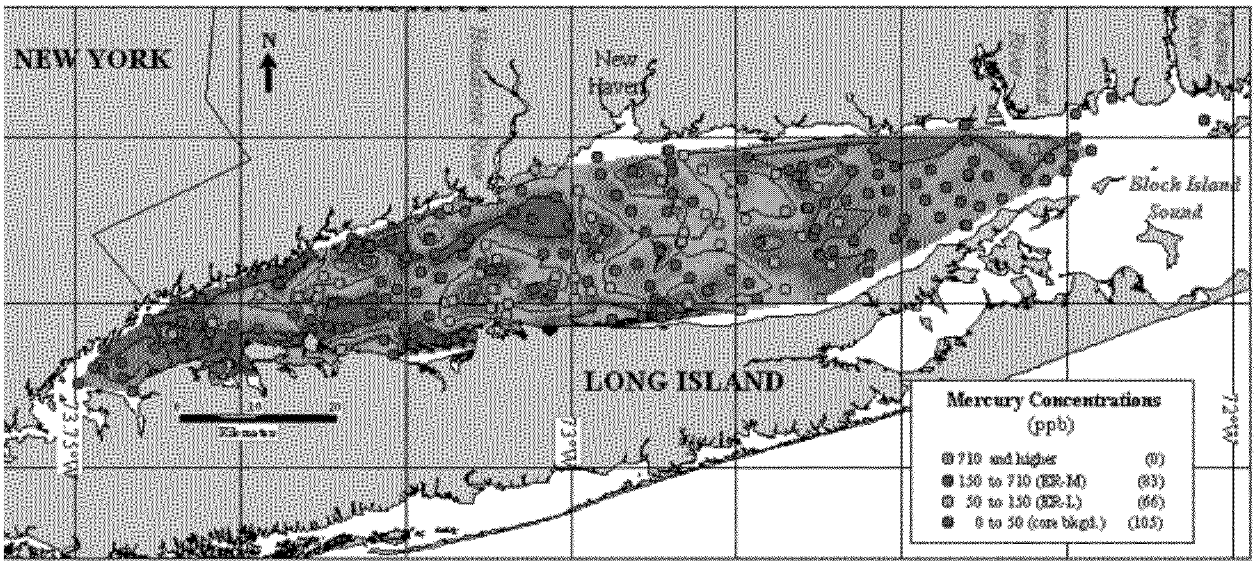


Figure 25. Concentrations of mercury (Hg) in LIS surface sediments, as an example of metals concentrations mapped by Mecray et al. (2000).

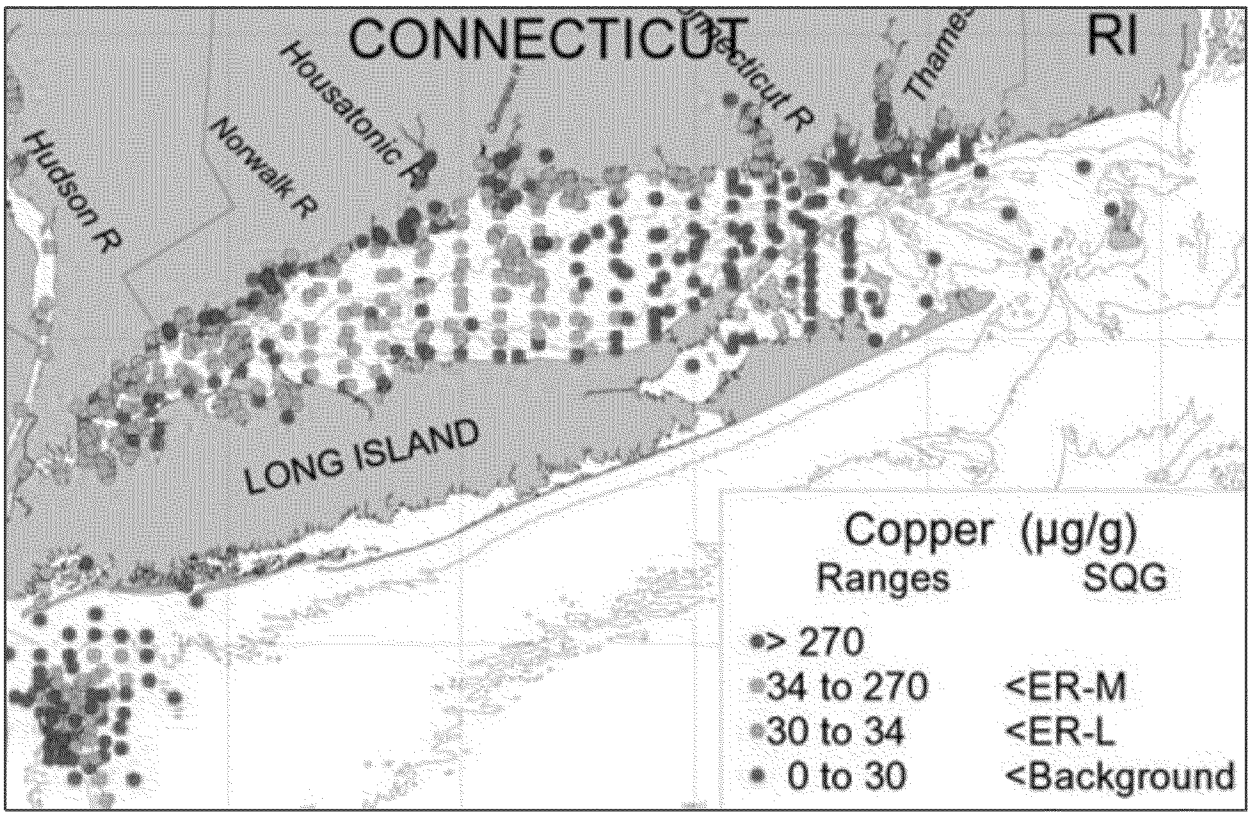


Figure 26. Copper concentration in surface sediments as an example of data in the USGS database (Mecray et al., 2003).

ED_001437D_00000426-00054

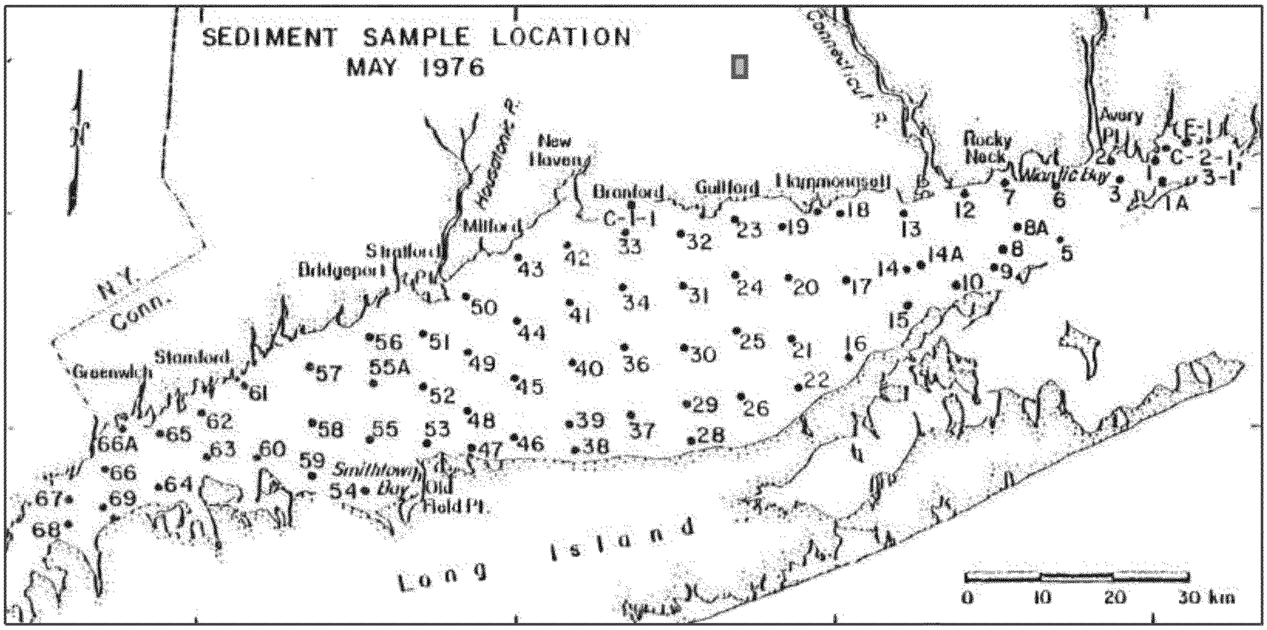


Figure 27. Sediment sample locations for grain size and metals in the study by Hunt (1979).

ED_001437D_00000426-00055

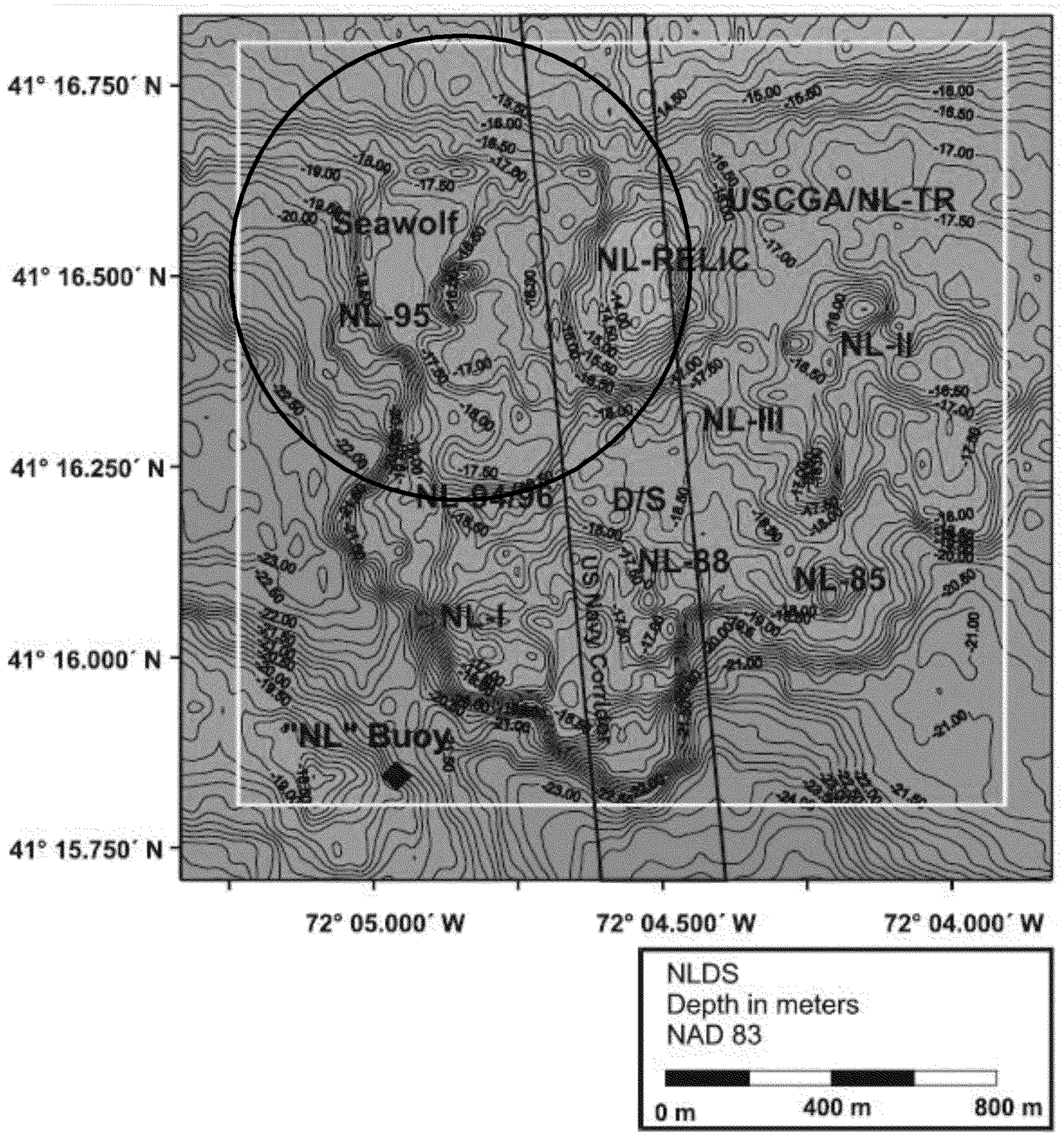


Figure 28. Sediment and benthic sampling around the Seawolf Mound at the NLDS (SAIC, 2004). Bathymetric information dates to 1997. The approximate location of the black circle in Figure 29 is marked.

ED_001437D_00000426-00056

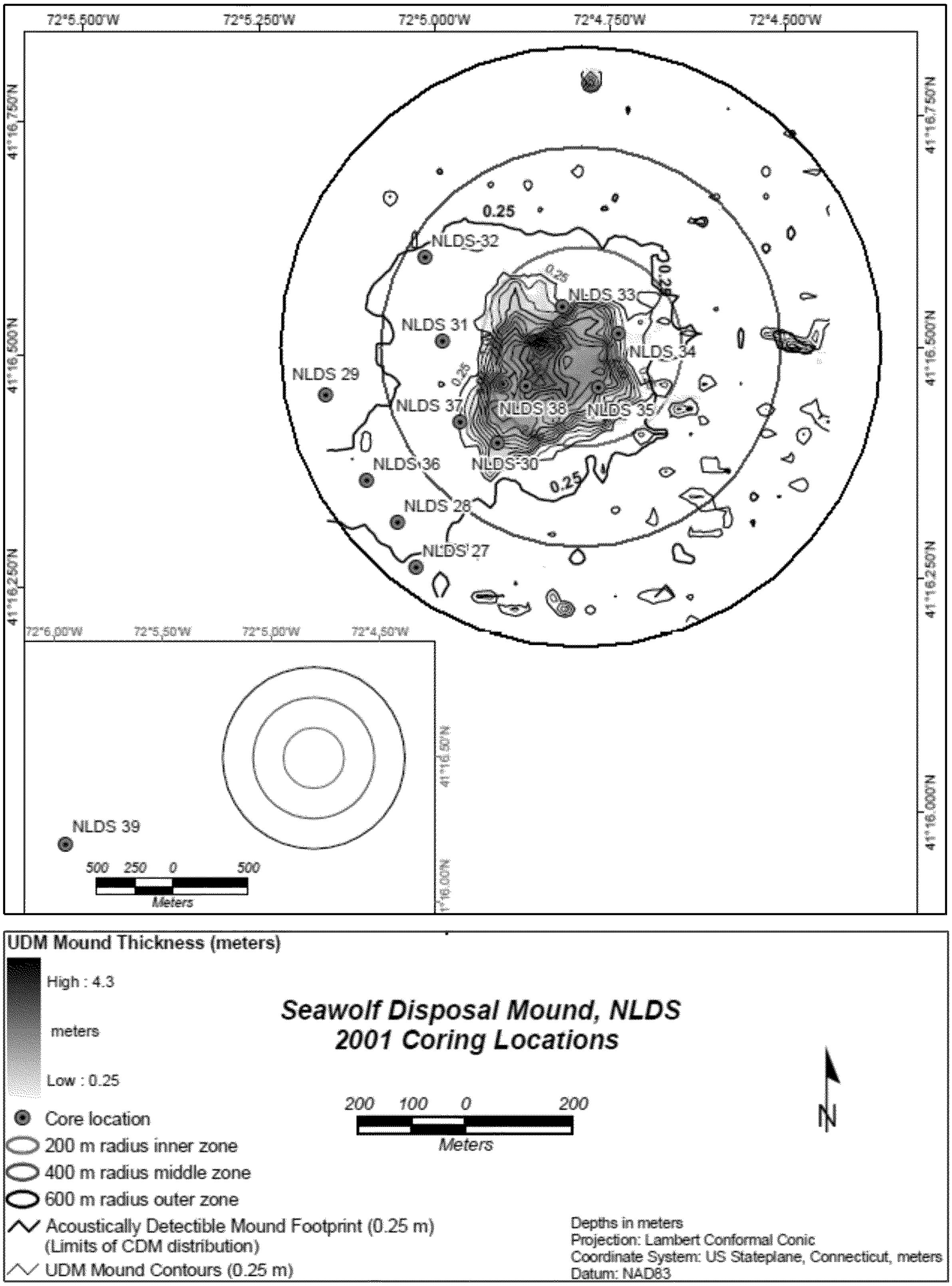


Figure 29. Coring locations at Seawolf Mound at the NLDS in 2001, and reference area core to the southwest (SAIC, 2004). See Figure 28 for overview and location of the black circle.

ED_001437D_00000426-00057

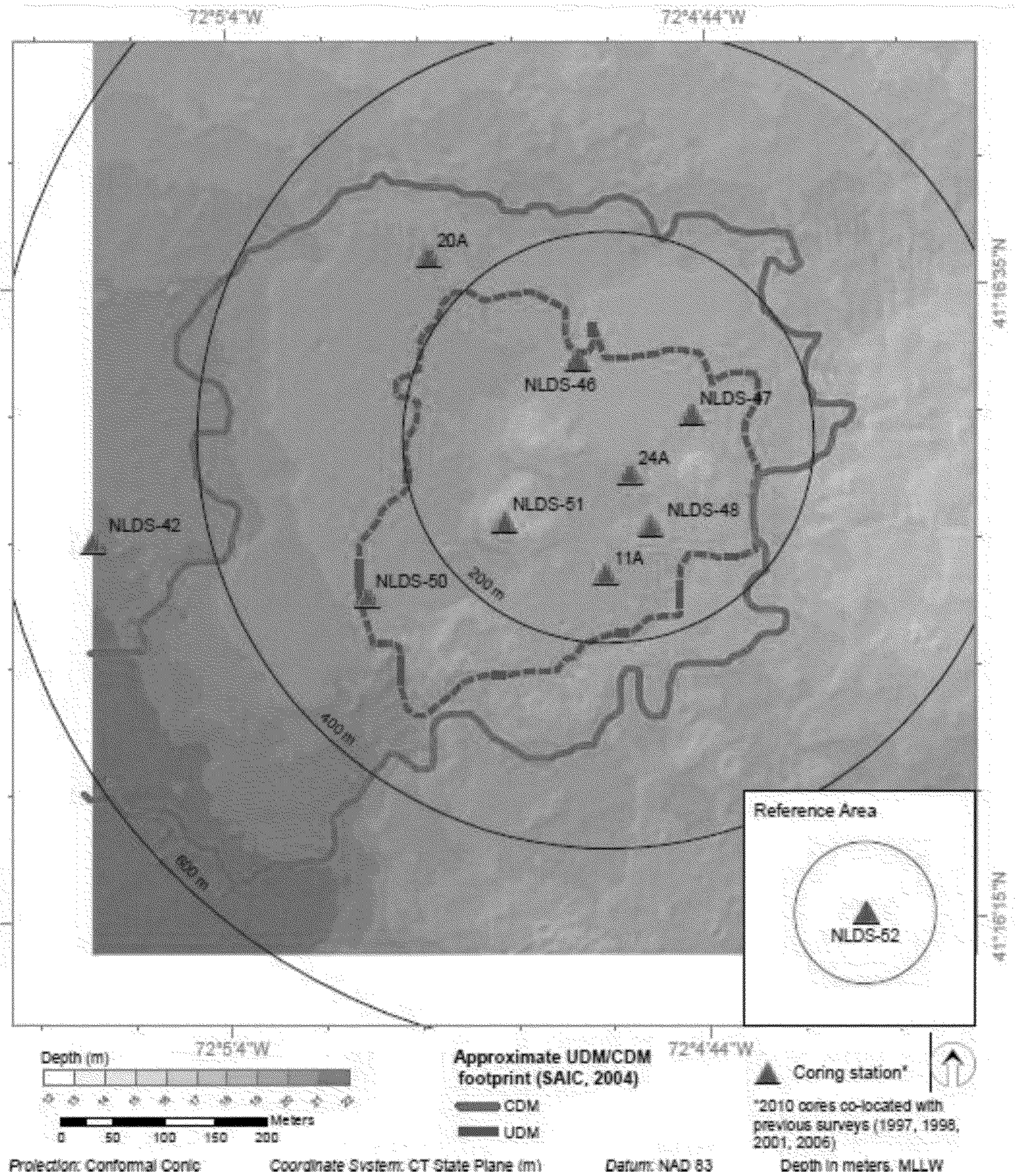


Figure 30. Coring locations at Seawolf Mound at the NLDS in 2010 (AECOM, 2012).

3.6.4 Organic Contaminants (PAHs, PCBs, Dichlorodiphenyltrichloroethane [DDT], dioxin/furans [PCDD/Fs], butyltins, radionuclides)

Data Needs: Information about organic contaminant concentrations in the surface sediment throughout the ZSF and at potential alternative disposal sites. In addition, information about major potential sources, both historic and present (*e.g.*, loading through Connecticut River, Thames River, stormwater runoff from urban coastal communities, deposited dredged material at active disposal sites) may be needed to address questions about the relationship between sources and detected concentrations in offshore sediments for the SEIS.

Existing Information: As stated above, Mecray et al. (2003) assembled a database with available published and unpublished data for contaminants in surface sediments in LIS, BIS, and the New York Bight. Data included pesticides, PCBs, and PAHs. An example of available data is presented in Figure 31.

For the WLIS/CLIS EIS, samples were analyzed from three alternative disposal sites (Bridgeport, Milford, and Central Long Island Sound). The results might be used only as a guide to the types of compounds present in LIS sediments, although concentrations in the coarser-grained ELIS sediments are expected to be lower on average. The RIR EIS and Broadwater EIS did not present data on organic compounds for the ELIS ZSF.

Mitch (2006) provided summary data for organic compounds (pesticides, PAHs, PCBs, dioxins) for the ELIS for the period from 1994 through 2005, although it is not clear from the study where stations of source data were located, how many data points were averaged, and thus how representative the data averages are for the ELIS. Yang et al. (2012) examined DDT and dieldrin in a core from the mouth of the Connecticut River, as well as nine other cores from coastal areas in CLIS and WLIS. Organic contaminant data are also available through NOAA's Mussel Watch and Benthic Surveillance Programs.

PAH concentrations in sediments at the Seawolf Mound within the NLDS were obtained by the DAMOS program (*e.g.*, AECOM, 2012; SAIC, 2004; see discussion in Section 3.6.3 above).

Potential Other Sources: Universities (UCONN, URI, SUNY Stony Brook, Yale University) may have additional sediment contaminant datasets, although data are expected to be limited in spatial extent.

Data Gaps: The available information that was located may be sufficient for the characterization of organic compounds in the sediments of the ZSF. A more in-depth review of the data assembled by Mecray et al. (2003) would be needed. Available data are not considered adequate, however, for the characterization of potential alternative disposal sites.

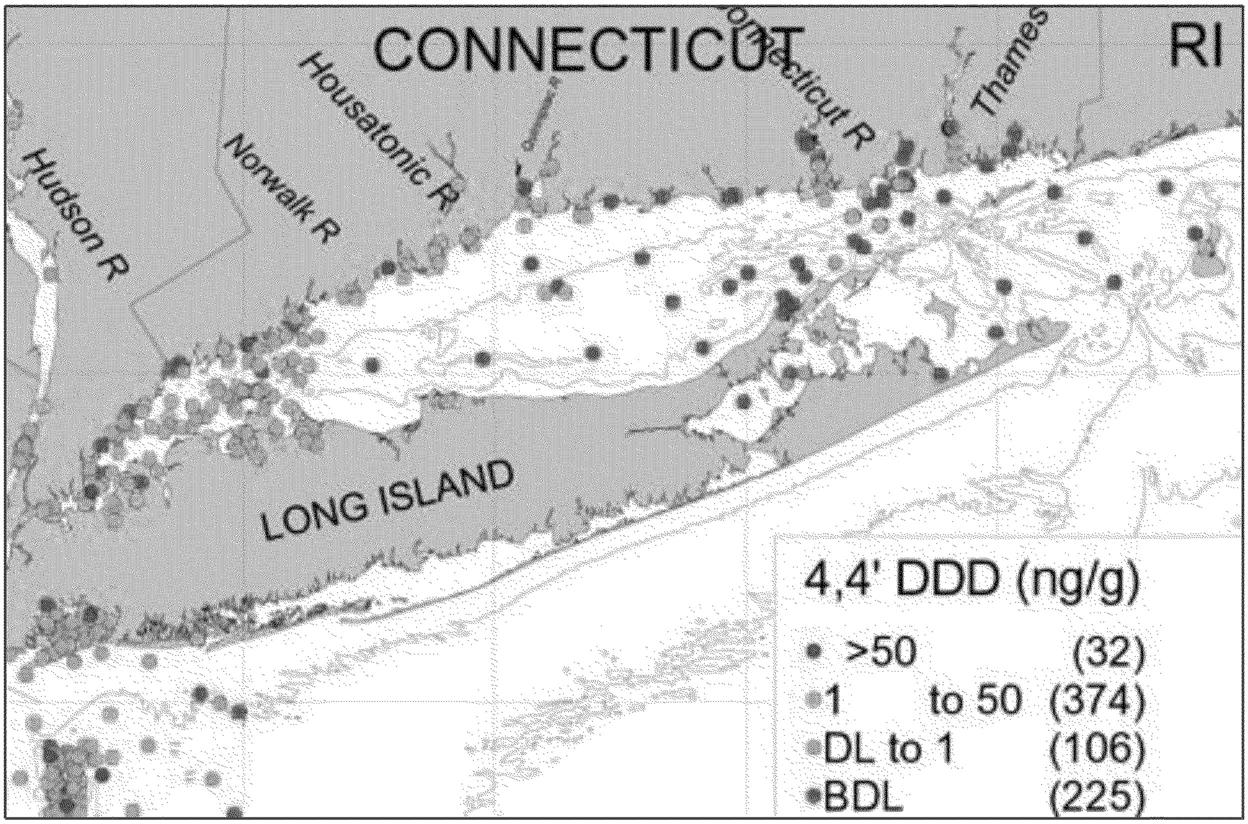


Figure 31. Example of organic compounds in surface sediments (pesticide 4,4'-DDD) from the USGS (Mecray et al., 2003).

3.6.5 Sediment Toxicity

Data Needs: Toxicological evaluation of sediments at potential alternative disposal sites.

Existing Information: For the WLIS/CLIS EIS, the potential toxicity of sediment from selected alternative disposal sites and appropriate reference locations was evaluated. Samples were collected in the field for physical, chemical, and toxicological evaluation and characterization of community structure. For the determination of sediment toxicity, mean survival in sediment by the amphipod *Ampelisca abdita* was compared between the alternative disposal sites and reference sites. Similar data were not located for any sites in the ELIS ZSF.

NOAA has been conducting a comprehensive studies of tissue concentrations within LIS as part of the National Status and Trends (NS&T) Mussel Watch and Benthic Surveillance Programs. These programs monitor contaminant levels over a long time to detect changes in the environmental quality of estuarine and coastal waters. An early study by Wolfe et al. (1994) examined the biological effects of toxic contaminants in sediments from LIS based on the NS&T data (Figure 32).

Potential Other Sources: Potential toxicity data may exist with in the USACE,; none were located in the DAMOS reports.

Data Gaps: Toxicity data may be needed for selected alternative disposal sites, specifically sites with fine-grained substrates such as NLDS. This need should be assessed further after review of the chemical data obtained during field studies in 2013.

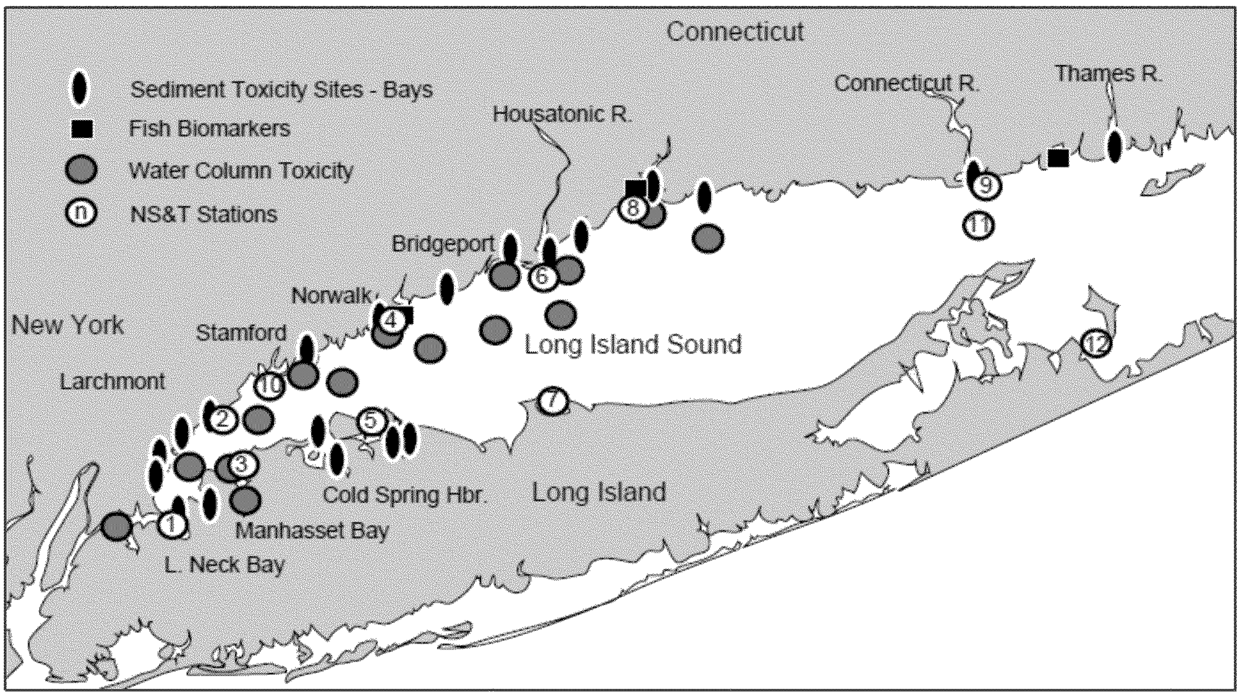


Figure 32. Sampling locations in Long Island Sound for sediment toxicity study in Wolfe et al. (1994).

3.7 Water Quality

Data Needs: Relevant water quality parameters including temperature and salinity, turbidity, nutrients, dissolved oxygen, pathogens, and organic compounds. Water quality data are needed for physical oceanography and for sediment transport modeling (*e.g.*, turbidity, suspended sediment, temperature, salinity) as well as for the understanding and assessment of impacts to the biological environment (dissolved oxygen, nutrients, metals, pathogen, organic compounds).

Existing Information: The CTDEEP performs an intensive year-round water quality monitoring program in LIS, on behalf of the Long Island Sound Study (LISS). Surface and bottom waters are monitored for water temperature, salinity, dissolved and particulate silica, dissolved and particulate nitrogen, dissolved oxygen, chlorophyll a, and total suspended solids. Sampling occurs monthly from October through May at 17 stations (Figure 3 3). Bi-weekly hypoxia surveys start in mid-June and end in September with up to 48 stations being sampled during each survey. Data are available since 1991. Publications listed in WHG (2010) consist of Olsen and Lyman (2003, 2004, 2008); more recent publications may also be available.

UCONN provides real-time data available on the Long Island Sound Integrated Coastal Observatory System (LISICOS) website. Monitoring equipment affixed to four buoys in LIS provide data on water temperature, salinity, and dissolved oxygen.

Background information is available in the CLIS/WLIS EIS and the Broadwater LNG EIS. Water quality information in the RIR EIS pertains primarily to the area east of Block Island (*i.e.*, outside of the ZSF for the ELIS SEIS).

As stated in WHG (2010), Dam et al. (2010) synthesized water quality and planktonic resource monitoring data for LIS. The analysis suggested that there are spatial variations in salinity, dissolved inorganic nitrogen (DIN), and chlorophyll in LIS due to differences at the extreme ends; temperature is stable; a declining trend in dissolved nitrogen and particulate matter over time; an increasing trend in phosphorous and silica over time; a declining trend in chlorophyll in the 1990s and subsequent rebound; no change in dissolved oxygen aside from a significant decrease in WLIS; no change in the spatial extent and severity of hypoxia; and no significant change in primary productivity since the 1950s. Study findings suggest that monitoring programs should be long-term (multi-decade) to be effective, that current reductions in nutrients have not been enough to impact hypoxia, and that it is too simplistic to assume that nutrient reduction reduces phytoplankton biomass and reduces hypoxia.

Sanudo-Wilhelmy and Gobler (2003) analyzed dissolved trace metals (Ag, Cd, Cu, Ni, Pb, Fe. Zn), inorganic constituents (ammonia, nitrate, phosphate and silicates), and organic constituents (urea, dissolved organic nitrogen, carbon and phosphorous, as well as particulate carbon and nitrogen) in the surface water of LIS with emphasis on sources (riverine, wastewater), cycling, and effects on phytoplankton growth. The study area (Figure 3 4) included nine stations in the ELIS ZSF. Samples were collected from a water depth of 1 meter (3 feet). The study found that during low flow conditions, the East River was the dominant external source of most trace metals (Ag, Cd, Cu, Ni, Pb, Zn). During high flow conditions the most important external source for metals (with the exception of silver) and nutrients was the Connecticut River. Detections of copper, nickel, and zinc under low-flow conditions indicate that remobilization of contaminated sediments is a large source in LIS. N utrient addition experiments indicate that increased nitrogen loading to LIS could spread the hypoxia problem from western LIS to central and eastern LIS waters.

Historical sewage-based pollution in LIS and BIS was investigated by Buchholtz ten Brink et al. (2000) by studying *Clostridium perfringens* in cores and surface sediments. This bacterium is a conservative tracer of sewage-derived pollution. Cores up to 70 cm (2.3 feet) long were collected throughout the ZSF (Figure 3 5); grab sampl es were collected only in the western part of the ELIS (Figure 24 above).

Water quality data analyses need to consider changes that have occurred over time. According to the Institute for Sustainable Energy (2003a), these include the following:

- Improvements to sewage treatment plants have decreased their discharge of nitrogen to LIS by 19% since 1990.
- Severity of hypoxia in LIS has decreased since the late 1980s.
- Concentrations of metals (*e.g.*, Cu, Ni, Pb, Zn) and organic compounds have declined in monitored LIS harbors. Releases of toxic industrial chemical releases in Long Island Sound's watershed have declined 84% between 1988 and 1998.

Potential Other Sources: Universities (*e.g.*, URI, UCONN, SUNY Stony Brook) may have additional datasets.

Data Gaps: Temperature, salinity, turbidity, and suspended sediment data will be collected as part of the physical oceanographic field program. The current LISS database and up- to-date data available from UCONN and other potential sources need to be reviewed in detail to determine if data gaps exist, although it is likely that available data are adequate for site screening and the impact assessment in the ELIS. In BIS, selected additional data may be needed for site characterization (*e.g.*, for the area north of Montauk).

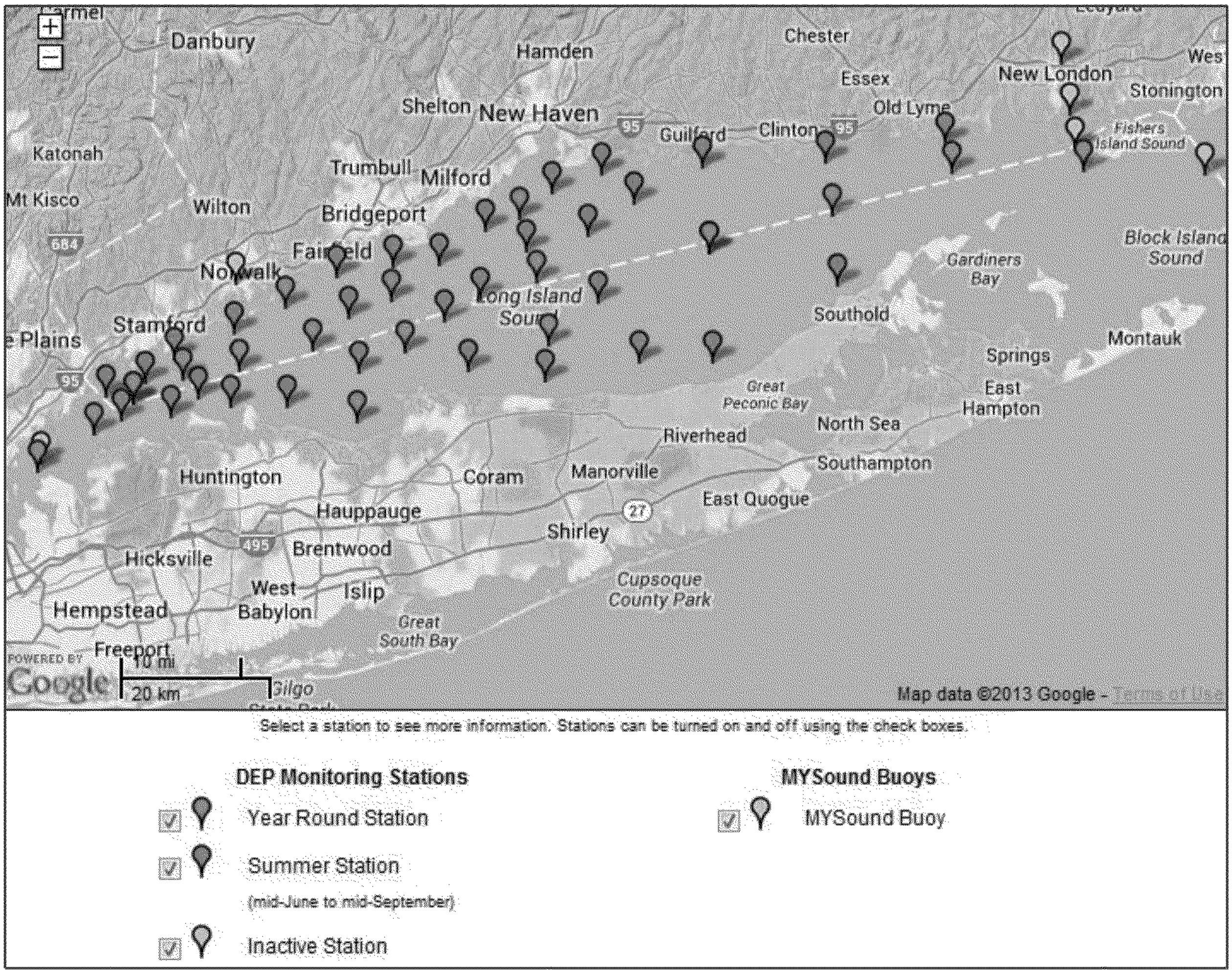


Figure 33. Station locations in the CTDEEP water quality monitoring program (CTDEEP, 2013a).

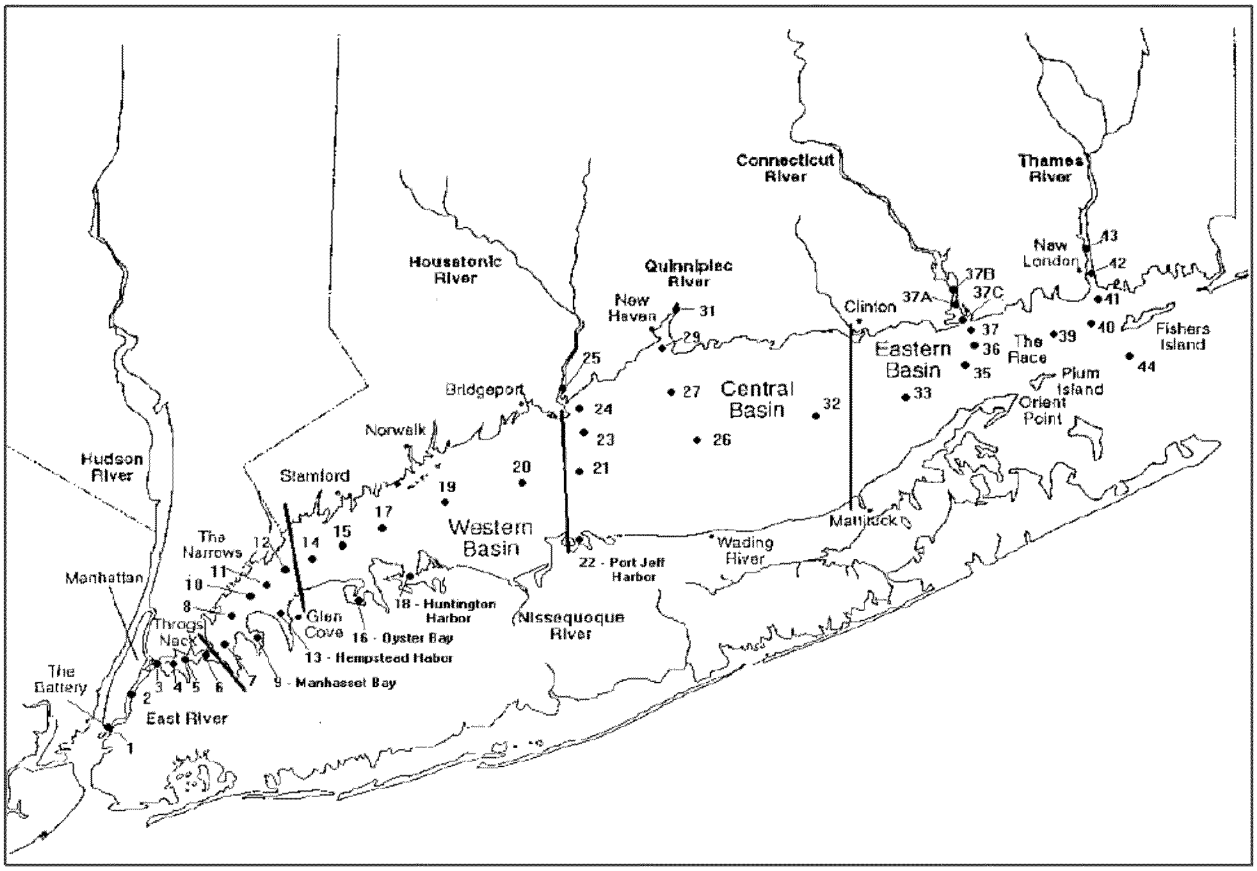


Figure 34. Stations used for the water quality study by Sanudo-Wilhelmy and Gobler (2003).

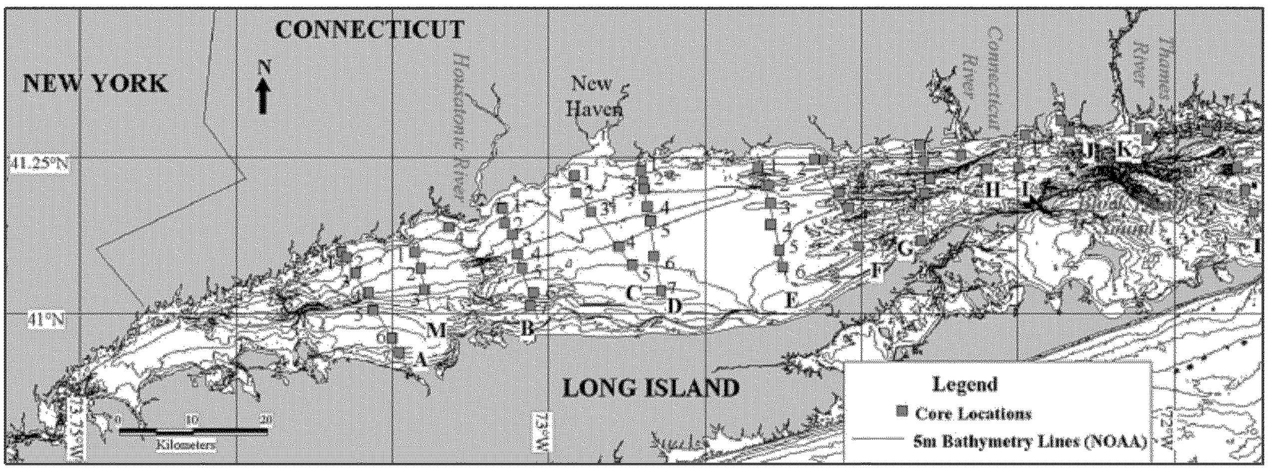


Figure 35. Sediment cores for geochemical analysis collected in June 1996 at 58 stations along north-south transects (Buchholtz ten Brink et al., 2000).

ED_001437D_00000426-00065

3.8 Plankton

Data Needs: General information about plankton in the ZSF, with particular emphasis on nuisance species responsible for toxic blooms.

Existing Information: The CLIS/WLIS and RIR EIS provide detailed information on both phytoplankton and zooplankton for the entire LIS and for BIS, respectively. Given the spatial and temporal (annual and seasonal) variability of planktonic species, this data is considered adequate for the ZSF. In addition, Dam et al. (2010) synthesized water quality and planktonic resource monitoring data for LIS. WHG (2010) listed additional references that indicate more recent information exists at UCONN and SUNY Stony Brook. For example, Ward et al. (2005) examined which environmental factors (*e.g.*, nutrients, hypoxia, temperature) are the primary determinants of phytoplankton assemblages and physiological condition of different species, and further examined the relationships between phytoplankton assemblages and planktonic grazers. Results suggested that seasonal temperatures, turbidity, dissolved oxygen and salinity affect the composition and abundance of phytoplankton in Long Island Sound less than nutrient loads. Goebel et al. (2006) modeled primary production throughout LIS using physiological parameters.

Another valuable tool to ascertain the distribution of phytoplankton in the ZSF is ocean color information obtained by satellites, which includes recent work by Dirk Aurin at UCONN. For example, Aurin and Dierssen (2012) presented seasonal phytoplankton taxonomic distribution based on analysis of high performance liquid chromatography pigment data using pigment ratios specific to LIS (Figure 3 6). The authors observed that "diatoms were prevalent in these high nutrient waters during all seasons and nearly all sub-regions. Cryptophyceae and prymnesiophycea are common during winter in eastern and western LIS, respectively. Crysophyceae are most prevalent in spring, and can be found mainly in central and eastern LIS. In summer, dinoflagellates are widespread throughout Long Island Sound, but they are uncommon in winter and spring. The diversity in phytoplankton taxa found in this study agrees with earlier studies conducted in Long Island Sound by the Connecticut Department of Environmental Protection (CTDEEP, 2005)." (p. 194-195)

Potential Other Sources: n/a

Data Gaps: None expected for both site screening and alternative disposal site analysis.

ED_001437D_00000426-00066

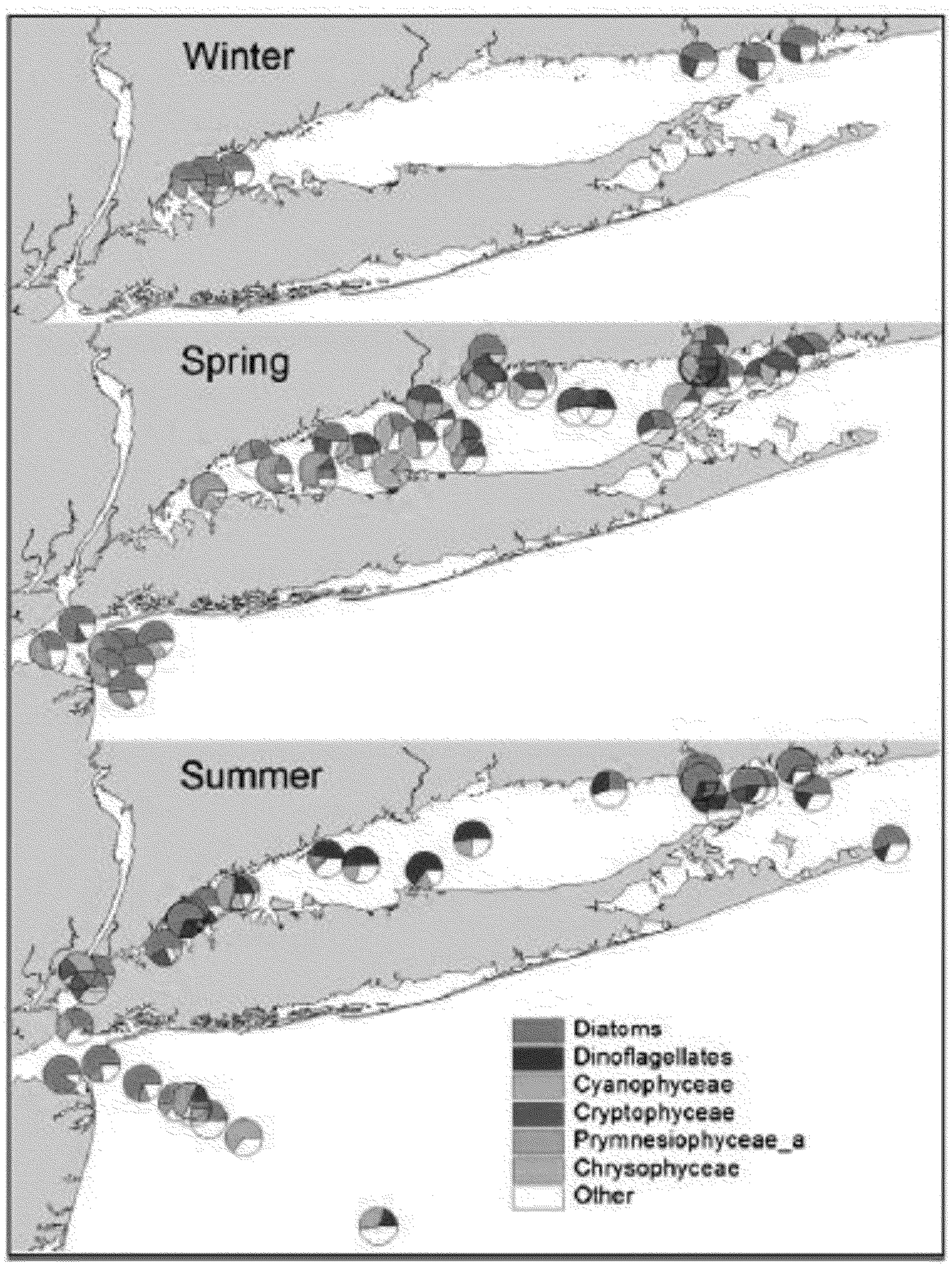


Figure 36. Seasonal phytoplankton taxonomic groups based on pigment analysis; for clarity, only the two most prevalent taxonomic groups at each station are shown explicitly (Aurin and Dierssen, 2012).

3.9 Benthic Environment

3.9.1 Benthic Invertebrates (shellfish, worms, etc.)

Most benthic organisms are invertebrates, which are animal species that do not develop a vertebral column. Examples of invertebrates include worms, clams, crabs, lobster, and starfish. Vertebrates are animals in the chordate subphylum Vertebrata that include fish, amphibians, reptiles, birds, and mammals. Discussed in this section are non-commercial benthic organisms, such as worms and crabs. Commercially harvested benthic organisms (oysters, clams, lobsters) are discussed in Section 3.11.

Data Needs: Benthic community information throughout the ZSF, and specifically at potential alternative disposal sites.

Existing Information: The CLIS/WLIS EIS provides benthic community information for the entire LIS based on key studies conducted during the 1950s, 1970s, and 1980s. As listed in the EIS, Sanders (1956) studied the benthos at eight locations in central LIS. From 1972 to 1978 Reid et al. (1979) conducted a much more extensive study with 142 stations in LIS from 1972 to 1978 (Figure 37). Pellegrino and Hubbard (1983) studied the benthos at 413 stations located in Connecticut state waters. Zajac (1998) and Zajac et al. (2000a) reanalyzed some of these data, and, based on these analyses, provided several GIS layers depicting the distribution of benthic communities in LIS, including benthic species richness (Figure 38). The material presented focused on deepwater areas (> 3-4 m). Zajac et al. (2000a) included a GIS data layer with detailed analysis of the 35 most common species found in LIS benthic communities, and a data layer for benthic communities found in the New London sidescan sonar mosaic study area.

Zajac et al. (2000b) observed that seafloor environments and associated infaunal communities in LIS are interconnected at various spatial scales, and stated further that particular sets of infaunal assemblages tend to be associated with particular sediment types as a result of the "interaction between sediment characteristics, geomorphology and hydrodynamics, and the resulting influence on the ecology of the benthic organisms via dispersal and settlement, resource availability and feeding, and modifications of local habitat conditions" (p. 637).

Zajac et al. (2003) studied the relationship between population abundance and seafloor landscape in a 19.4 km^2 area southwest of Fishers Island using side-scan sonar (Figure 39). The area included the northwestern corner of the NLDS. He stated that infaunal populations exhibited complex and spatially varying patterns of abundance in relation to 'benthoscape' structure, and suggested that mesoscale variations may be particularly critical. The largest number of species and total abundance of infaunal organisms were observed in the mixed/rubble sediment of the NLDS; the smallest number of species and abundance were observed in sand waves (Figure 40). Number of species and abundance in other benthoscape elements (mud/sand, sand, boulder/cobble/outcrops) were similar, suggesting that infaunal assemblages are not a critical element for site screening, considering that areas with morphologies reflecting active sediment transport (such as sand waves) may not be considered as disposal areas. Considering the link between benthic organisms and sedimentary environment, the multibeam bathymetric surveys conducted by NOAA/USGS provide a basis for the understanding of existing benthic habitats.

Available information on benthic organisms in BIS was compiled as part of the EIS for the Naval Submarine base dredging EIS (U.S. Navy, 1973). In addition, benthic sampling was conducted in selected areas including at the edges of the eastern and central deep holes south of Fishers Island Sound.

The Rhode Island SAMP reviewed available data for BIS and used roughness "as a first approximation proxy for habitat complexity" (RICRMC, 2010; Figure 41). A note on the SAMP map states the following (chapter 2, p. 74): "Surface roughness is one measure used to assess the complexity of ecological habitat, with the relationship between roughness and diversity being well documented. For this work, roughness is measured as the standard deviation of the slope within a 1,000 meter (3,300 feet) radius. This measure was chosen to enhance transition zones or areas where the benthic topography changes rapidly across small areas and may indicate complex habitat structure. These data are only one of the needed pieces of information to develop an accurate classification of benthic communities."

Flood et al. (2003) conducted the first phase of a benthic survey in Peconic Bay to characterize regional variability and to demonstrate the approach.

Aside from benthic sampling, there are photographs and images available throughout the ZSF:

- Poppe et al. (2000b) presents photographs in Niantic Bay, including the historic Niantic Bay Disposal Site, considered representative examples of common benthic characters and sedimentary environments present throughout LIS.

- In BIS, the National Marine Fisheries Service (NMFS) conducted surveys in 1976 to collect data on the infaunal communities (Steimle, 1982; summarized in the RIR EIS, 2004b, and in RICRMC, 2010). A dditional benthic work was done by Steimle in western BIS (1990). Photographs were also taken as part of the multibeam bathymetric survey in ELIS (*e.g.*, Poppe at al., 2011) and the eastern BIS (Poppe et al., 2012a; Figure 42); photographs collected in western BIS are still being processed and will be available in 2014 (Larry Poppe, USGS, personal communication, July 3, 2013).

- UCONN has a library of videos taken since 1988 along the sediment/water interface throughout the ZSF (Ivar Babb, personal communication, June 25, 2013; Figures 43 to 46). These videos include the following areas for potential disposal sites (west to east): Six Mile Reef, Cornfield Shoals, New London, the three deep holes south of Fishers Island Sound, and an area north of the Block Island Sound Disposal Site. The extent of relevant information in thes e videos is not known at this time and would require their review.

The benthic community within the Seawolf Mound at the NLDS was assessed in 2001 using a Remote Environmental Monitoring of the Seafloor (REMOTS) camera (also referred to as a Sediment Profile Imaging [SPI] camera) and grab samples. At each of the six stations (Figure

ED_001437D_00000426-00069

47), total faunal abundance and number of benthic species were calculated. Older DAMOS reports also contain benthic information from the NLDS.

Potential Other Sources: University researchers (*e.g.*, UCONN, University of New Haven, SUNY Stony Brook).

Data Gaps: Available data and information, along with the detailed multibeam mapping by the NOAA/USGS, provide a basis for site screening ; however, the available benthic information is not considered sufficient to characterize selected alternative disposal sites. Additional sediment profile imaging should be performed. In addition, benthic infauna samples should be collected to allow for sediment quality triad analysis (Long and Chapman, 1985; Chapman, 2000), using a similar approach to that performed for the WLIS/CLIS EIS.

Some of these data gaps might be covered by a multi-agency study targeted for parts of LIS (Battista and O'Brien, 2012). A pilot study has been conducted in central LIS. One of the next priority areas covers much of the ELIS. Project components include benthic habitats and ecological processes, acoustic intensity and seafloor mapping, sediment texture and grain size distribution, sedimentary environments, and physical and chemical environments. The schedule for the work has not yet been determined but may shift into 2014 (Kevin O'Brien, CTDEEP, personal communication, July 17, 2013). Researchers planning to participate include the following (among others): sediment (Larry Poppe, USGS), benthic infauna (Roman Zajac, University of New Haven), benthic epifauna (Peter Auster, UCONN), photo and video-drift data (Ivar Babb, UCONN), and physical oceanography (James O'Donnell, UCONN).

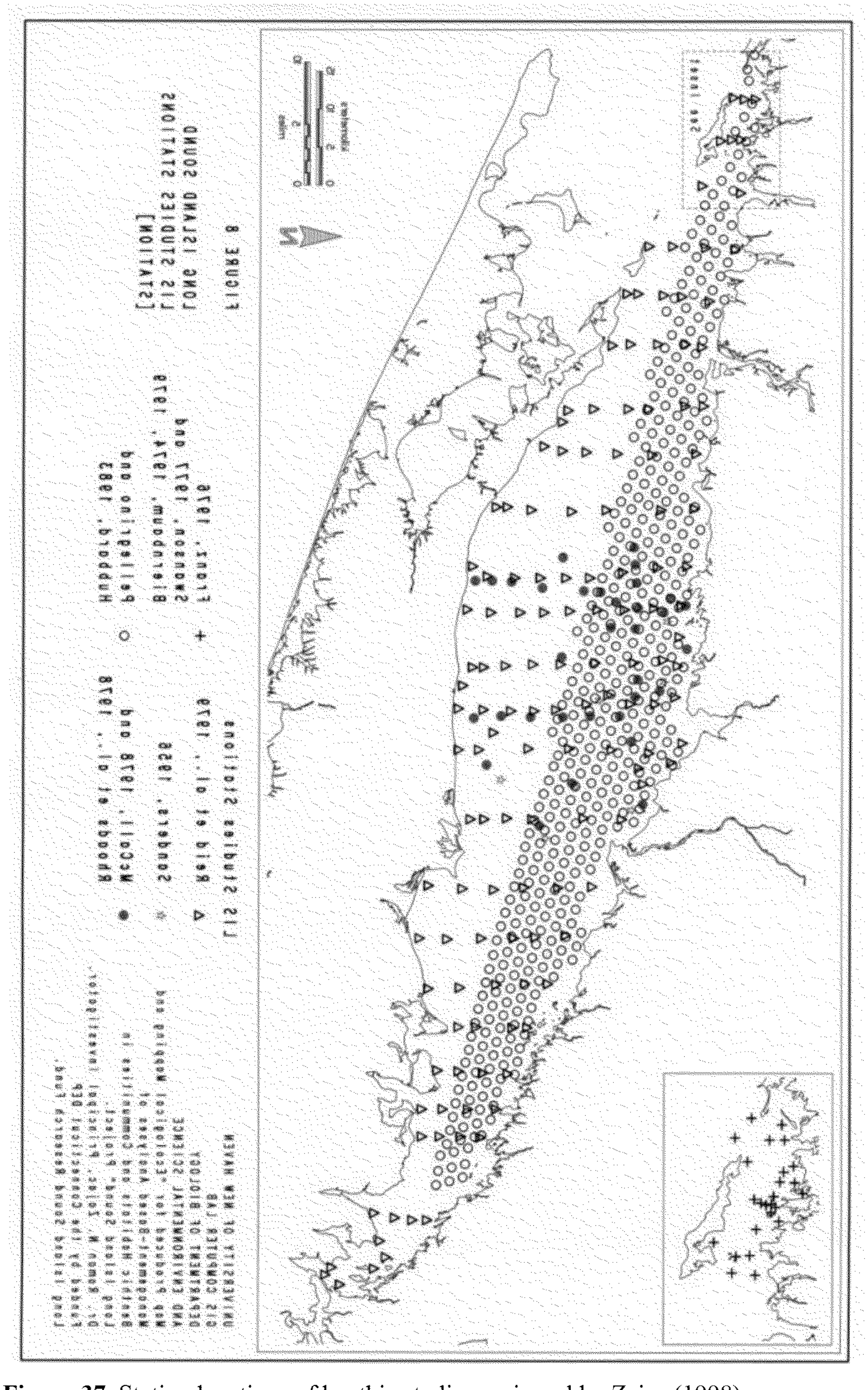


Figure 37. Station locations of benthic studies reviewed by Zajac (1998).

ED_001437D_00000426-00071

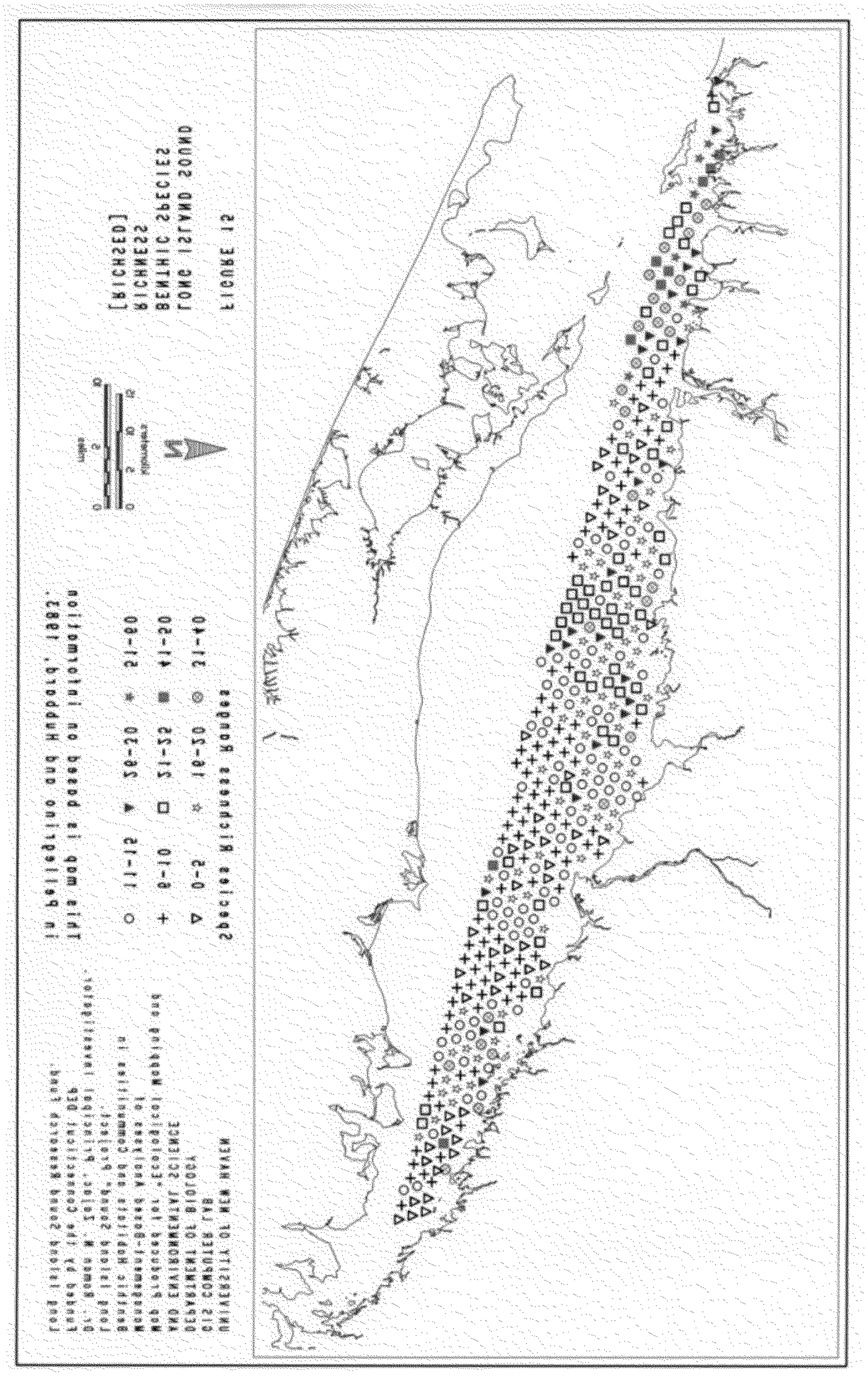


Figure 38. Benthic species richness determined by Pellegrino and Hubbard (1983, as provided in Zajac, 1998). Generally, species richness increases from west to east in LIS, possibly due to factors such as proximity to a larger species pool outside the waters of LIS and physical conditions, such as salinity, and greater habitat heterogeneity.

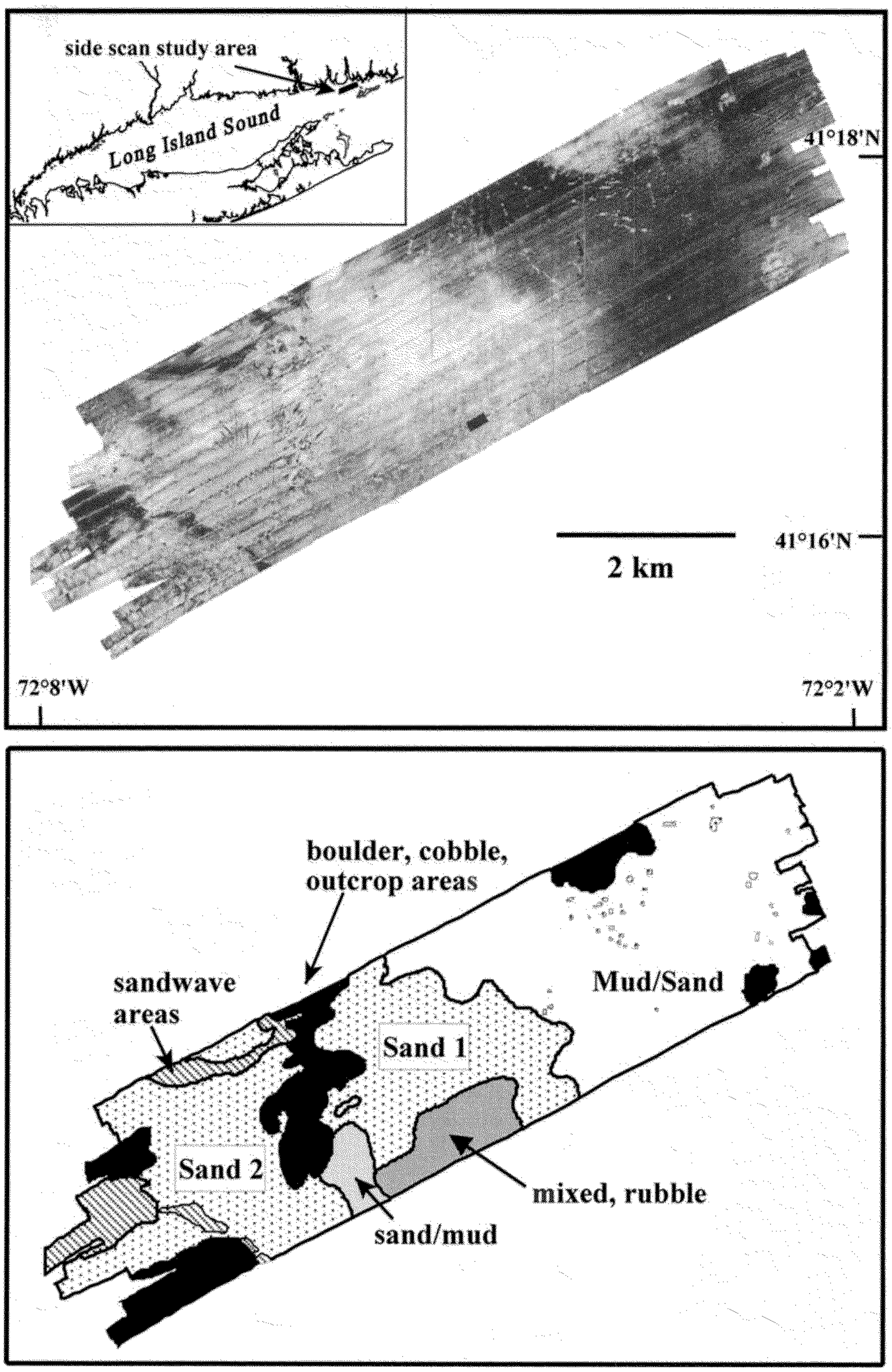


Figure 39. Sidescan sonar mosaic of area for benthoscape study and sediment types (Zajac et al., 2003). The project area includes the northwestern corner of the NLDS, reflected by the sediment type "mixed, rubble".

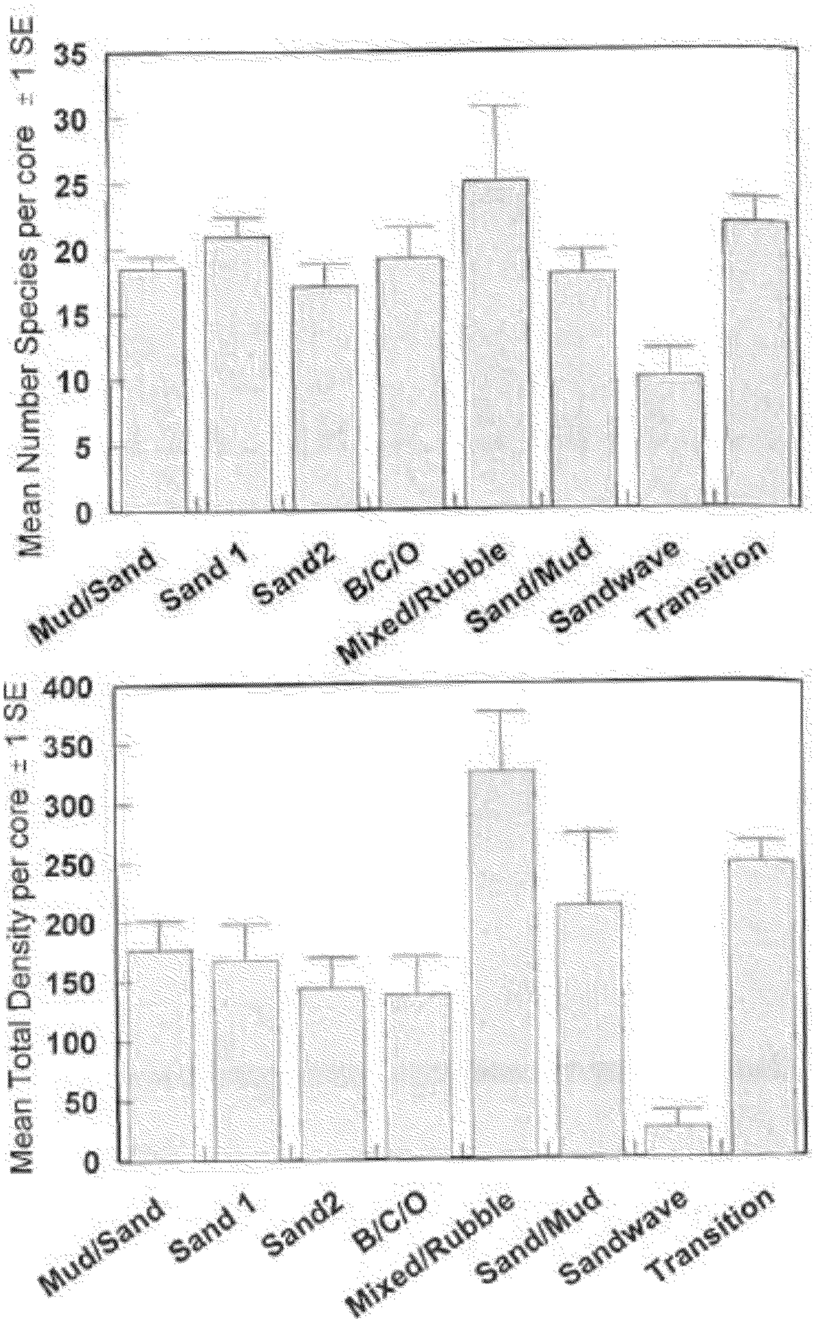


Figure 40. Total species per core and total abundance in each of the large-scale benthic areas (Figure 37) as reported in Zajac et al. (2000b).

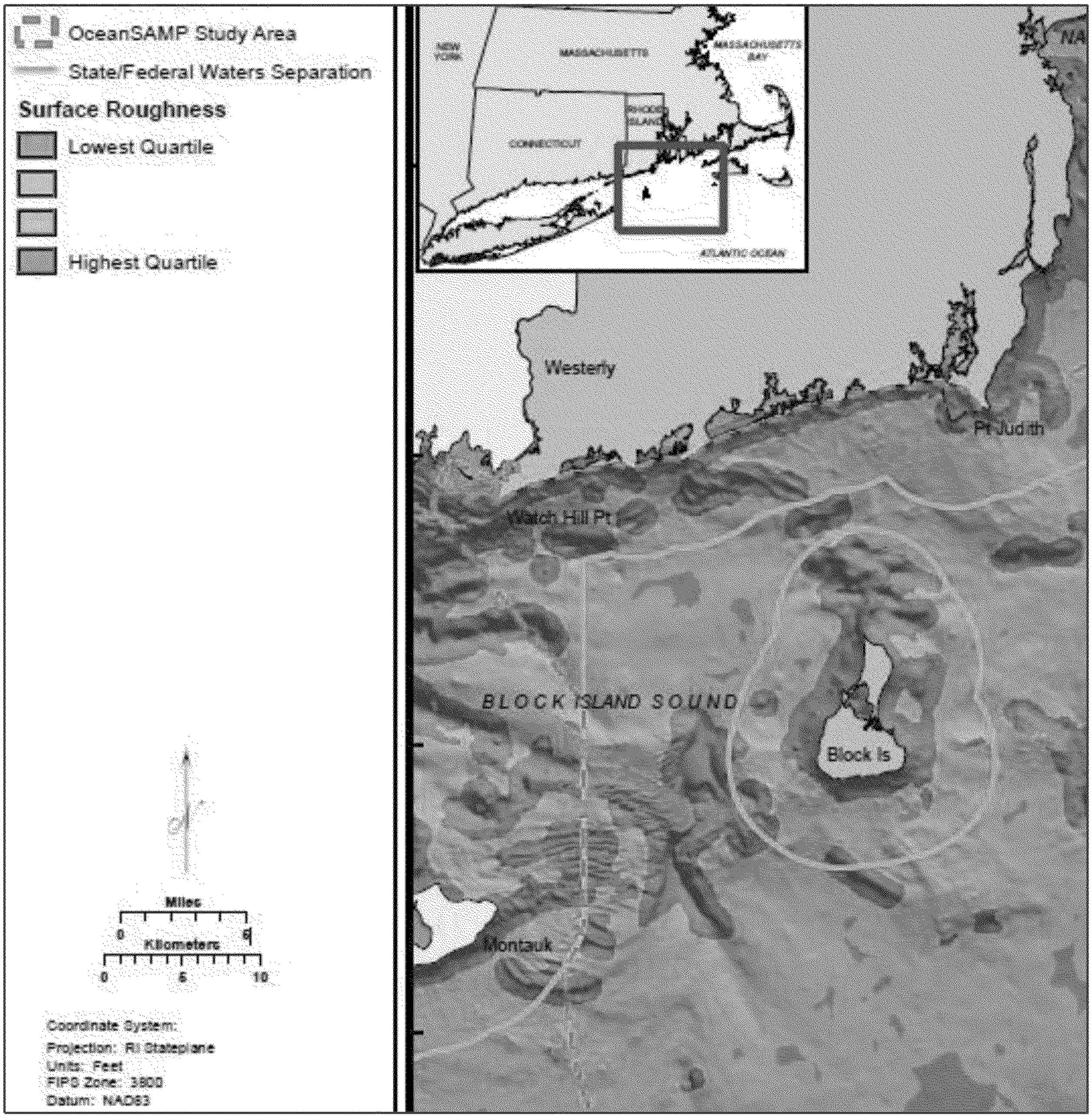


Figure 41. Surface roughness in BIS (RICRMC, 2010).

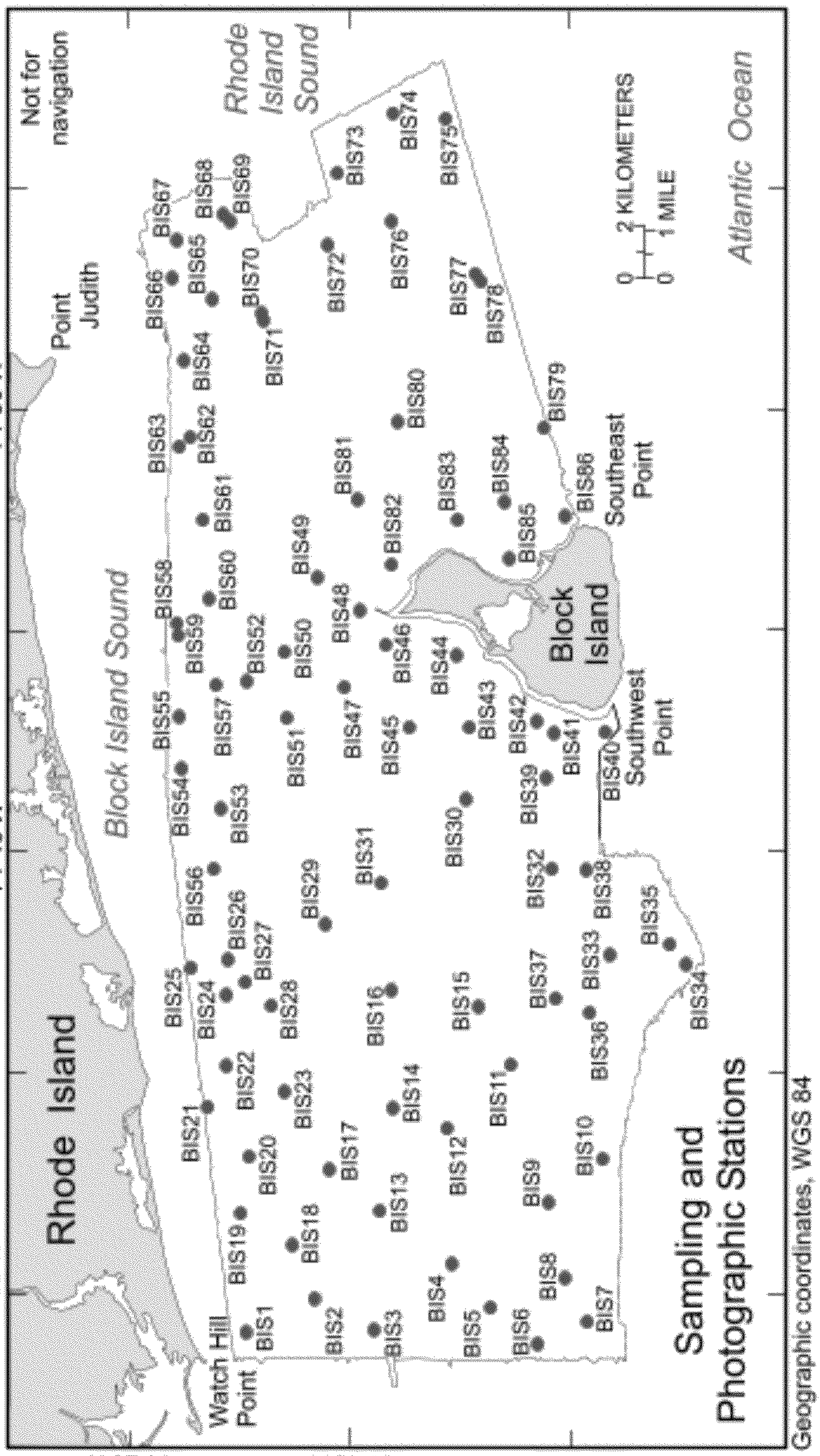


Figure 42. Locations of bottom photographs taken during USGS cruise 2011-006-FA in BIS (Poppe et al., 2012a).

ED_001437D_00000426-00076

Figure 43. Locations in BIS and Fishers Island Sound with video coverage of the sediment/water interface, available from UCONN (Ivar Babb, personal communication, June 25, 2013).

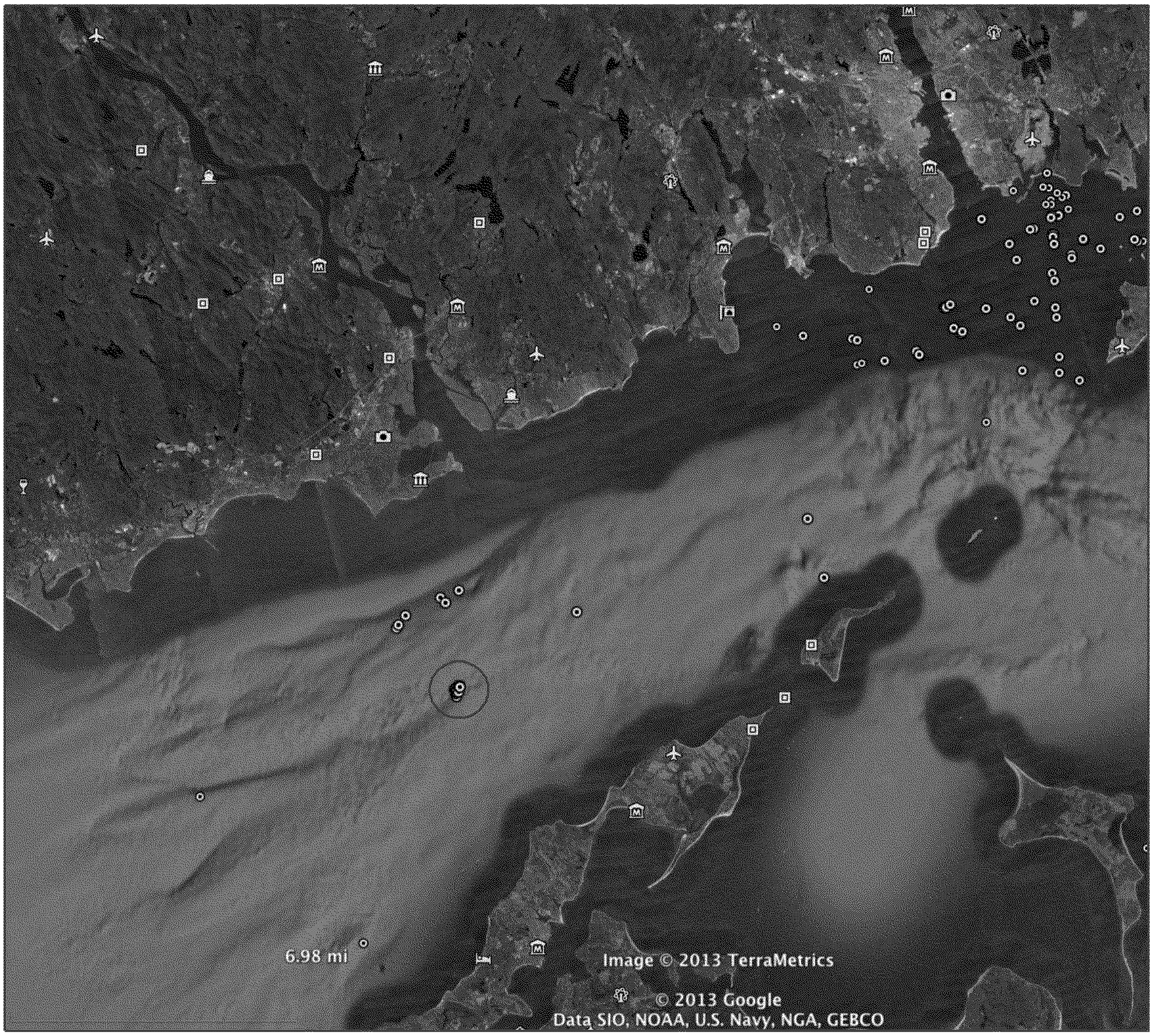


Figure 44. Locations in ELIS with video coverage of the sediment/water interface, available from UCONN (Ivar Babb, personal communication, June 25, 2013). A closeup of the stations at the Cornfield Shoals Disposal Site (within the red circle) is shown in Figure 46.

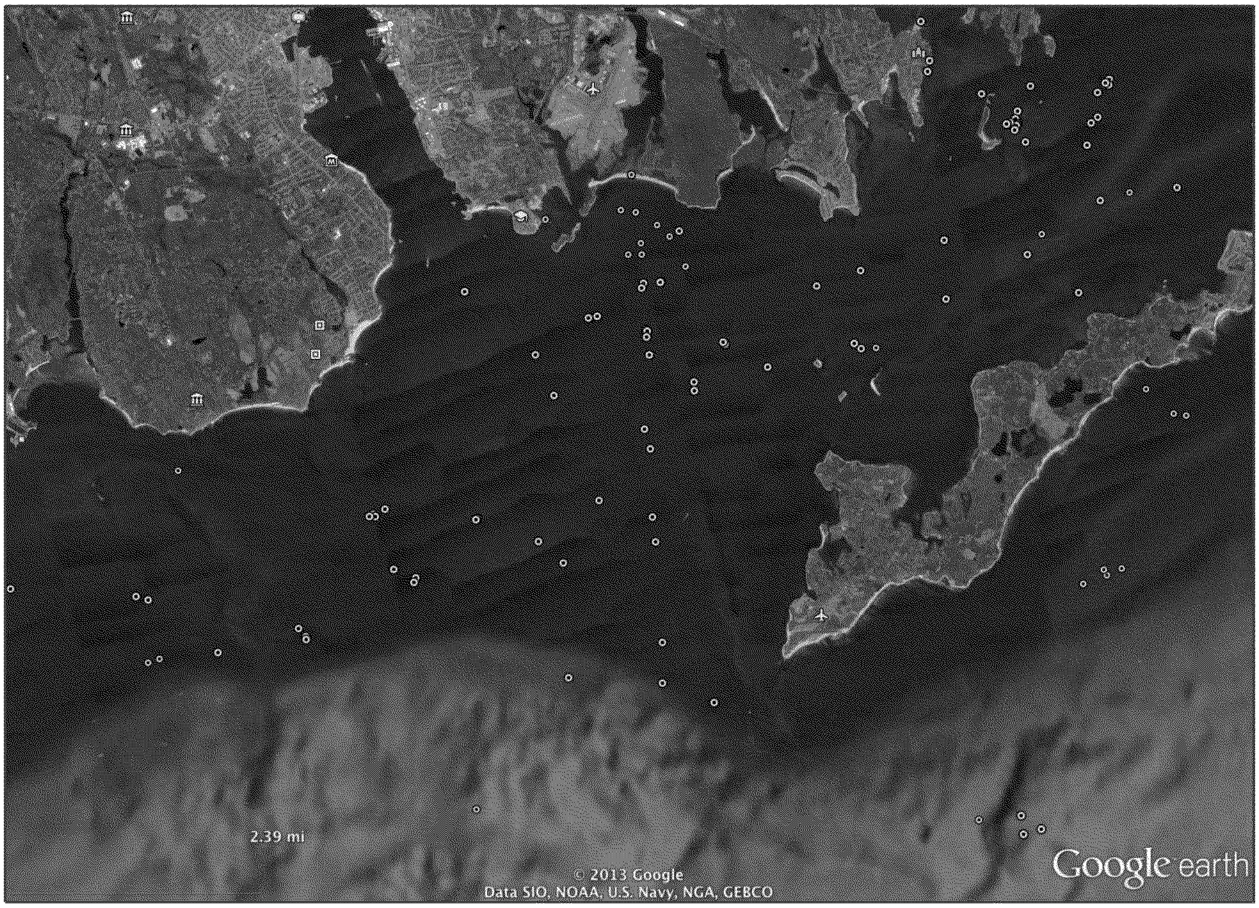


Figure 45. Closeup of Fishers Island Sound with video coverage of the sediment/water interface, available from UCONN (Ivar Babb, personal communication, June 25, 2013).

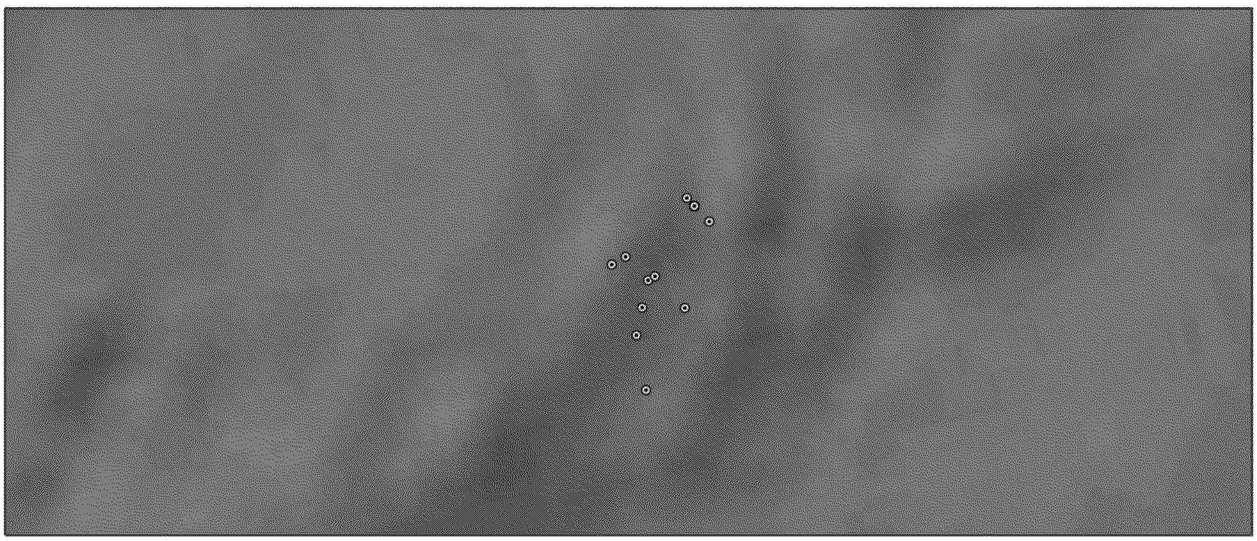


Figure 46. Locations at Cornfields Shoals in ELIS with video coverage of the sediment/water interface, available from UCONN (Ivar Babb, personal communication, June 25, 2013) (see Figure 44 for location of stations). .

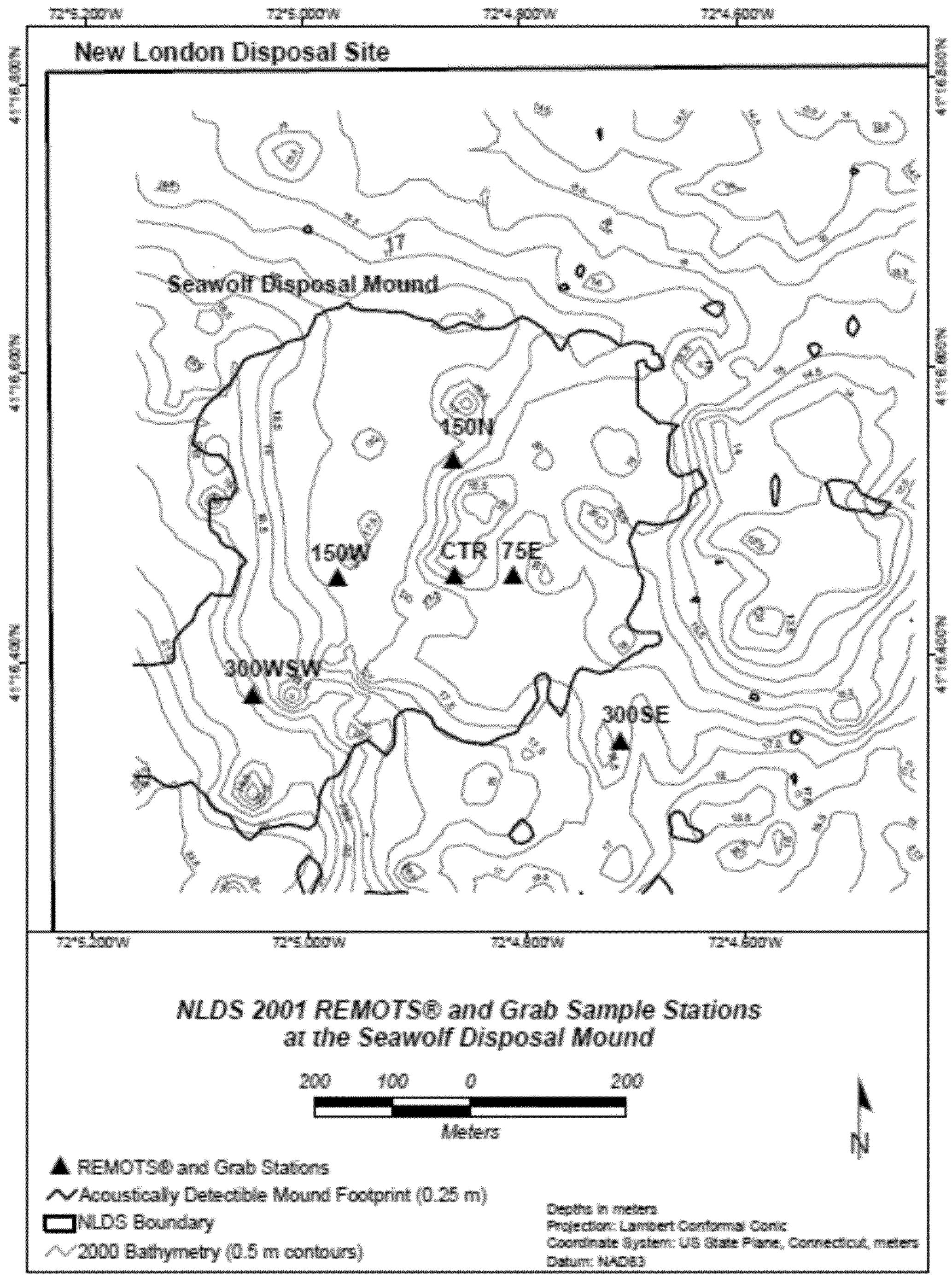


Figure 47. Benthic sampling stations at the Seawolf Mound at the NLDS (SAIC, 2004). An overview of the site is shown in Figure 28.

3.9.2 Eelgrass Beds

Data Needs: Distribution of eelgrass beds throughout the ZSF. Eelgrass beds are important habitats for marine and estuarine biota.

Existing Information: Data of the distribution of eelgrass beds have been identified for CT and RI; the CT survey included Fishers Island and part of Long Island (Figure 48).

Connecticut: The USFWS National Wetlands Inventory Program conducted eelgrass inventories for the eastern part of EL IS in 2002, 2006, and 2009 (Tiner et al., 2003, 2006, 2010). The GIS eelgrass bed data were downloaded from the CTDEEP website (see Section 2.3 above for further information.)

New York: The CT surveys included Fishers Island and the n orth shore of Long Island. Additional data for Long Island were not located.

Rhode Island: Data on SAV in Rhode Island Coastal Waters were downloaded from the RIGIS website; information includes areas of "eelgrass" and "widgeon grass and eelgrass" . These data were developed by the Rhode Island Eelgrass Mapping Task Force. Polygons of SAV were delineated from photo-signatures identified on 4-band orthophotography. G round-truthing was performed after initial delineations using underwater video equipment and Geographic Positioning Systems (GPS). F eatures characterized as "eelgrass" and "widgeon grass and eelgrass" are depicted in the mapping. B eds characterized as "widgeon grass" only are not shown.

Available eelgrass information in the ZSF is presented in Figure 49.

Potential Other Sources: Potential sources for additional data along Long Island's shores may include UCONN (Jamie Vaudrey), SUNY Stony Brook, NYSDOS, and NYSDEC.

Data Gaps: Additional data may be needed for the coast of Long Island for the areas around Montauk and Gardiners Island, should an alternative disposal site be proposed in their vicinity.

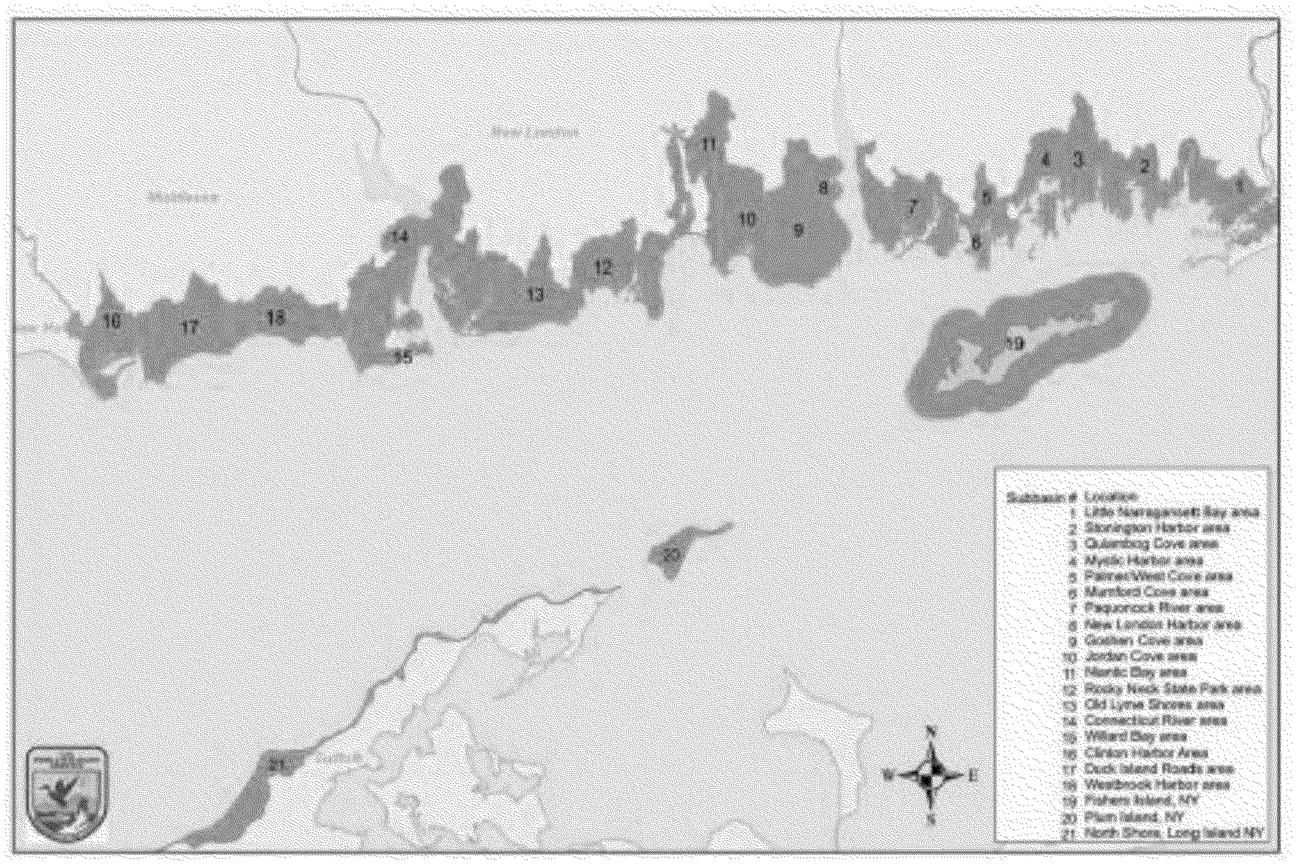


Figure 48. Study area for eelgrass beds (Tiner et al., 2010).

ED_001437D_00000426-00082

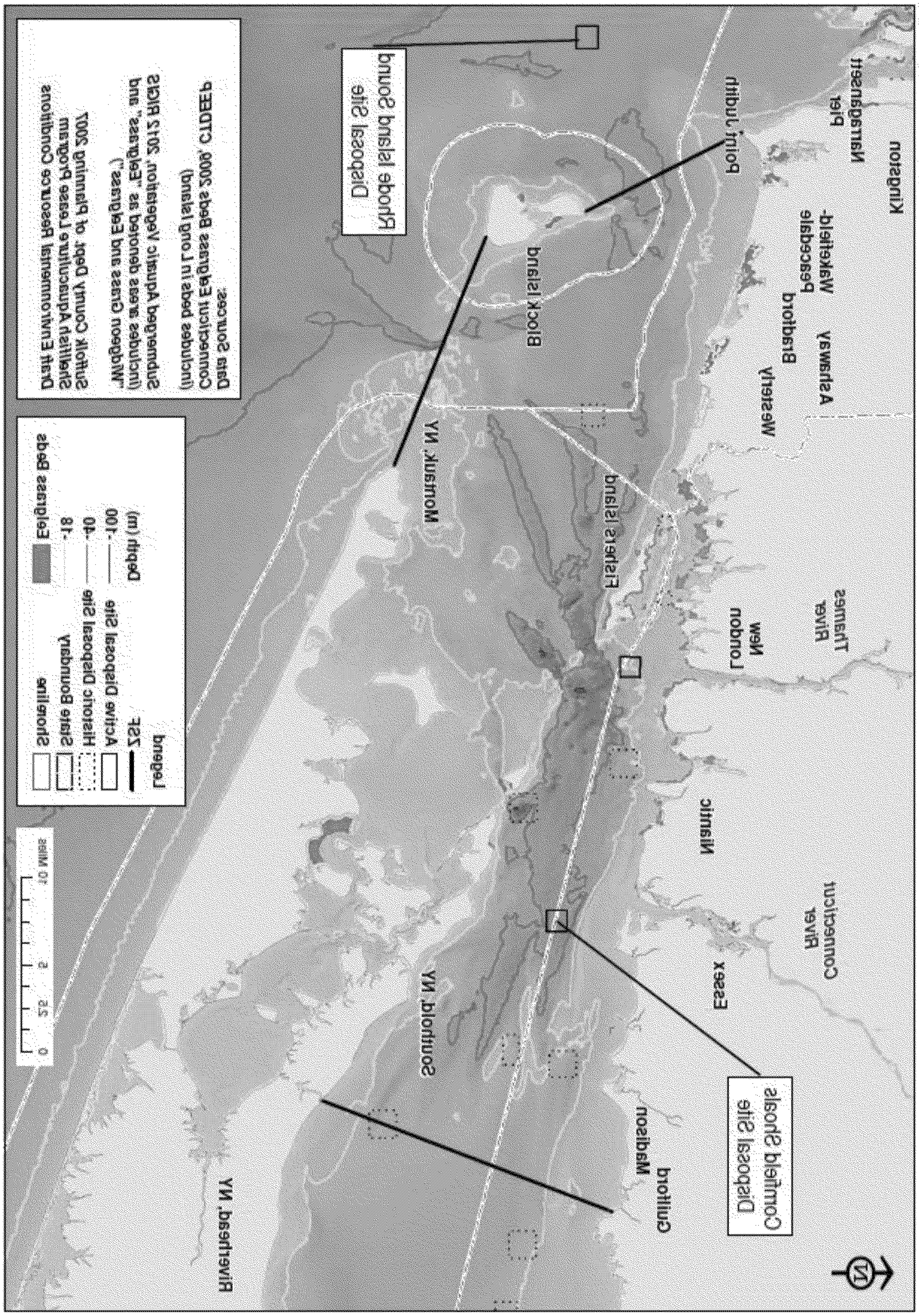


Figure 49. Eelgrass beds in the ZSF (GIS compilation; June 24, 2013)

ED_001437D_00000426-00083

3.10 Finfish Resources

3.10.1 Finfish Distribution

Data Needs: Data that characterize finfish resources throughout the ZSF, to understand the resource value for finfish in general and for individual species to the extent possible.

Existing Information: The LIS is home to numerous finfish species of ecological, commercial, and recreational value. At least 96 finfish species are known to occupy LIS (Gottschall et al., 2000, 2006). CTDEEP Marine Fisheries Division has been conducting bottom trawl surveys in LIS for 28 years since 1984; the most recent published survey results are from 2011 (CTDEEP, 2012a). The survey area ranges from New London to Greenwich, Connecticut, and includes waters from 5 to 46 m (16 to 150 feet) in depth in both Connecticut and New York state waters (Figure 50). Typically, LIS is surveyed in the spring, from April through June, and during the fall, from September through October. CTDEEP (2012a) includes results from the 2011 spring and fall sampling periods and provides time-series information since the commencement of the survey in 1984 (Figure 51).

The CLIS/WLIS EIS provides a detailed synthesis of trawl data from 1984 to 2000. Additional trawl survey data were considered and integrated in the analysis for the Broadwater LNG project (FERC, 2008). The CLIS/WLIS EIS data synthesis shows some trends but also considerable spatial variability in average catch-per-unit-effort (CPUE) (Figures 52 and 53). Recently, CTDEEP Marine Fisheries Division provided updated information that included data up to 2012 (Figures 54 and 55). There is also considerable variability on a macroscale between finfish CPUE and habitat (Figure 56). Aside from total biomass and CPUE data, such data are also available for individual fish species (Deborah Pacileo, CTDEEP, personal communication, August 2, 2013). The long-term record by CTDEEP is a valuable and relevant dataset to assess spatial and temporal variability in fisheries resources within the Long Island Sound, including the ELIS. This includes, for example, the observation by Howell and Auster (2012) of changes in finfish distribution in LIS between 1984 and 2008 as a result of warming temperatures.

New York State relies on Connecticut's trawl survey data and does not collect fishing data systematically (Stephen Heins, NYSDEC, personal communication, July 15, 2013). While fishermen fill out fishing trip reports, these reports together are not necessarily representative for the region. Lobster fishermen also fill out reports but data may also not be representative. Trap data are more visible; it would require local data collection to better understand lobster fishing activities locally (such as for example in areas around Orient Point and Montauk). There are no mapped finfish 'hot spots', but fishing activity seems to be higher in the area between Plum Island and Orient Point (Plum Gut), The Race, and south of Fishers Island, due to elevated tidal velocities.

For BIS, the RIR EIS integrated data from the University of Rhode Island –Graduate School of Oceanography (URI-GSO), Rhode Island Division of Fish and Wildlife (RIDFW), and Massachusetts Division of Marine Fisheries (MDMF), all of whom conducted long-term research trawl surveys at locations within or adjacent to the ZSF for the RIR EIS (Figure 57). Only the

RIDFW data were within the ZSF for the ELIS SEIS. The RIR EIS also integrated data on commercial fisheries collected by NMFS; these data were also outside the ZSF for the ELIS SEIS (Figure 58). In addition, trawl surveys conducted between 1999 and 2002 in support of the RIR EIS were all to the east of Block Island, *i.e.,* also outside of the ZSF for the ELIS SEIS. More recent information is probably available at the RIDFW. For example, the 2013 Management Plan for the Finfish Fishery Sector (RIDFW, 2012a) provides information on stock status and performance of fishery and quotas. Restricted finfish include scup, summer flounder, tautog, striped bass, black sea bass, and winter flounder. Non-restricted finfish include bluefish, menhaden, monkfish, and cod.

The SAMP (RICRMC, 2010) mapped available trawl locations in Block Island Sound (Figure 59). Stations are available through RIDEM and the North East Area Monitoring and Assessment Program (NEAMAP[2]). Data were used to compute biomass (Figure 60). The SAMP further includes information on fish resources in BIS.

Potential Other Sources: Current databases at NMFS, state agencies (RIDFW, CTDEEP, NYSDEC), and universities (UCONN, URI, SUNY Stony Brook).

Data Gaps: The CTDEEP fish trawl database are expected to be adequate for characterizing fisheries resources in the ELIS; in essence, there is fishing throughout the LIS. The available data may also be adequate for potential alternative disposal sites in the ELIS. The exception may be areas of the historic Orient Point Disposal Site, where, due to its bathymetry with comparatively steep slopes, local fish concentrations and habitats may exist. In addition, the benthic environment of the northern part of the historic Clinton Harbor Disposal Site would need to be better understood to evaluate its finfish resource potential; this area, not fully covered by the NOAA/USGS multibeam survey, appears to contain areas with boulders.

For BIS, additional data would need to be obtained (from potential other sources listed above) and reviewed to determine potential data gaps both for BIS in general, and for the potential alternative disposal sites. Specifically, the three deep holes south of Fishers Island may contain unique finfish habitats, similar to the Orient Point Disposal Site. In addition, the area north of Montauk may contain a somewhat different finfish community due to the proximity of the area to the open Atlantic Ocean to the east and the protected embayments surrounding Gardiners Island to the west.

[2] NEAMAP was developed by the Atlantic States Marine Fisheries Commission (ASMFC) to coordinate fisheries independent monitoring activities in the northeastern United States.

ED_001437D_00000426-00085

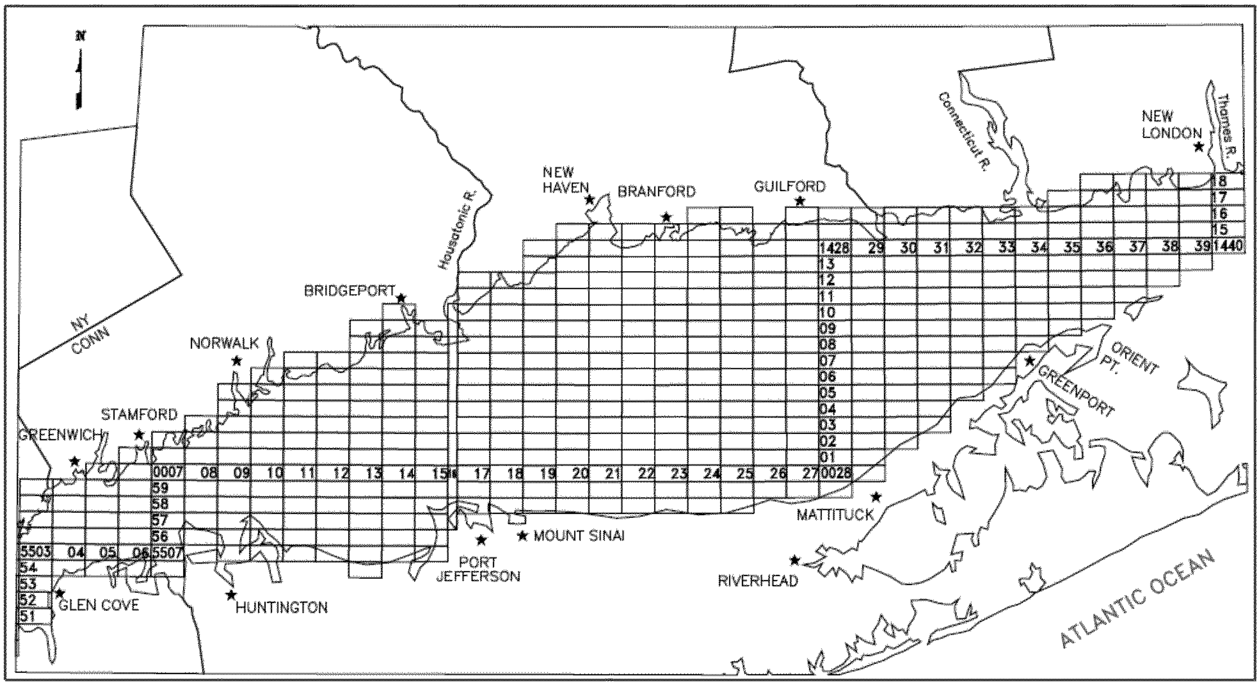


Figure 50. Trawl survey site grid (CTDEEP, 2012a). Each rectangular sampling site is 1x2 nautical miles.

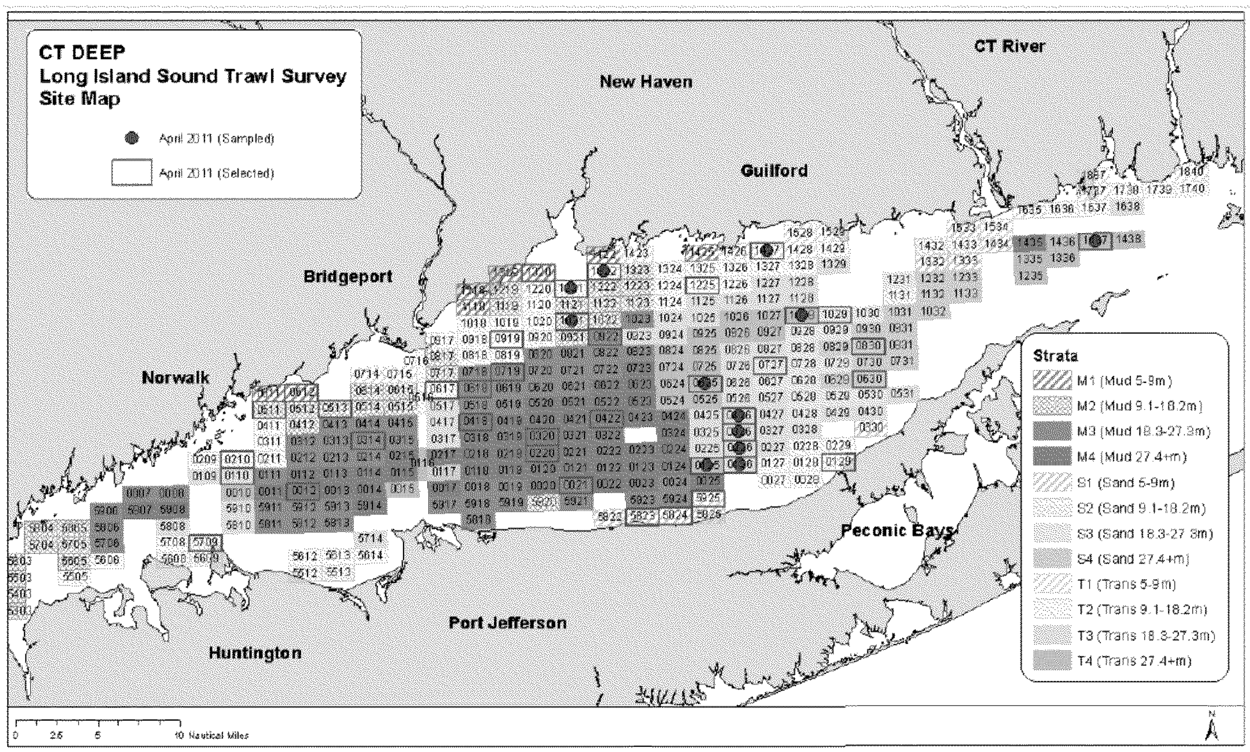


Figure 51. Example of fish trawl survey (April 2011; CTDEEP, 2012a). Red-outlined boxes indicate areas that were surveyed.

ED_001437D_00000426-00086

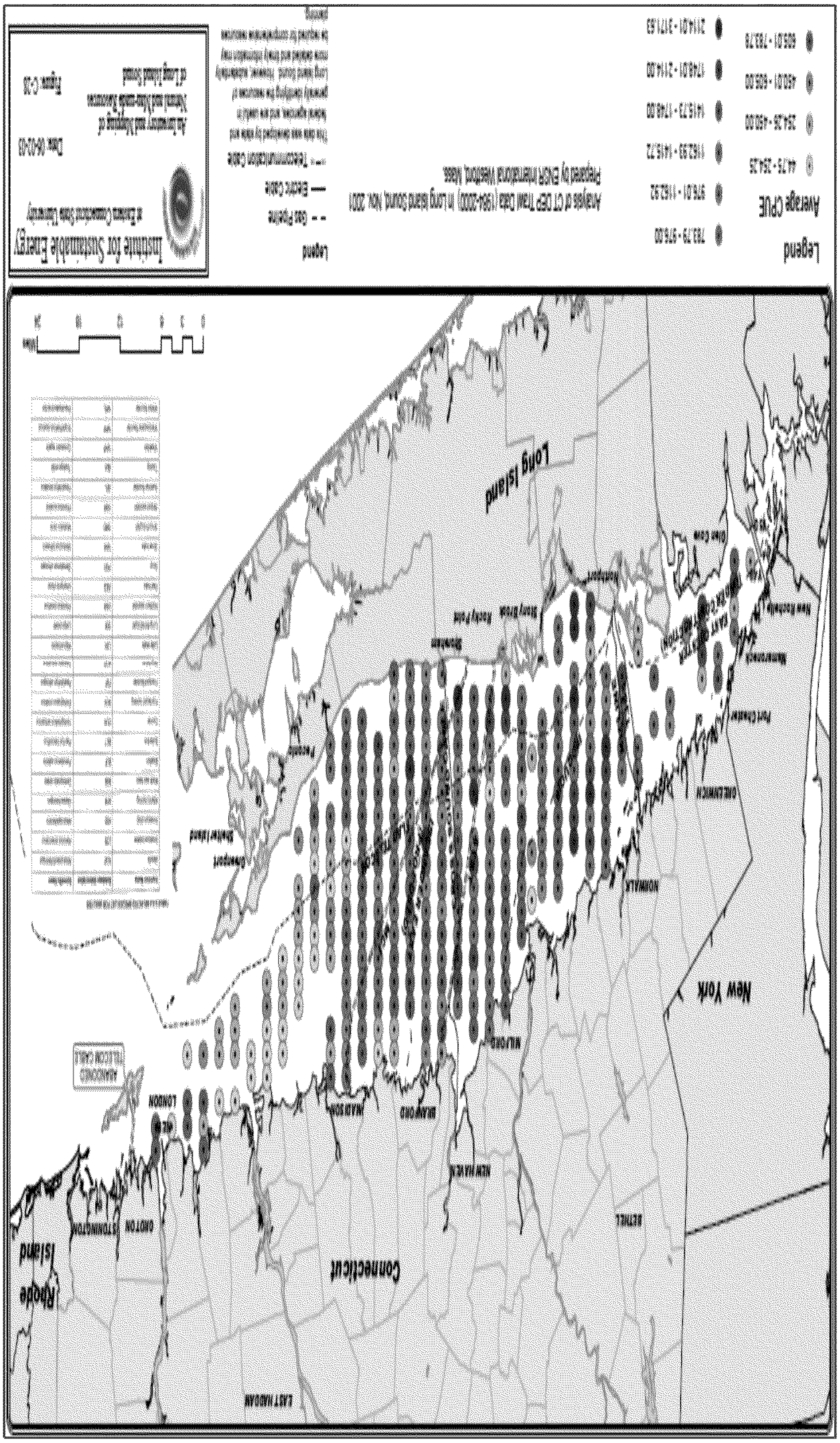


Figure 52. Finfish catch-per-unit-effort (CPUE), 1984-2002 (Institute for Sustainable Energy, 2003b).

ED_001437D_00000426-00087

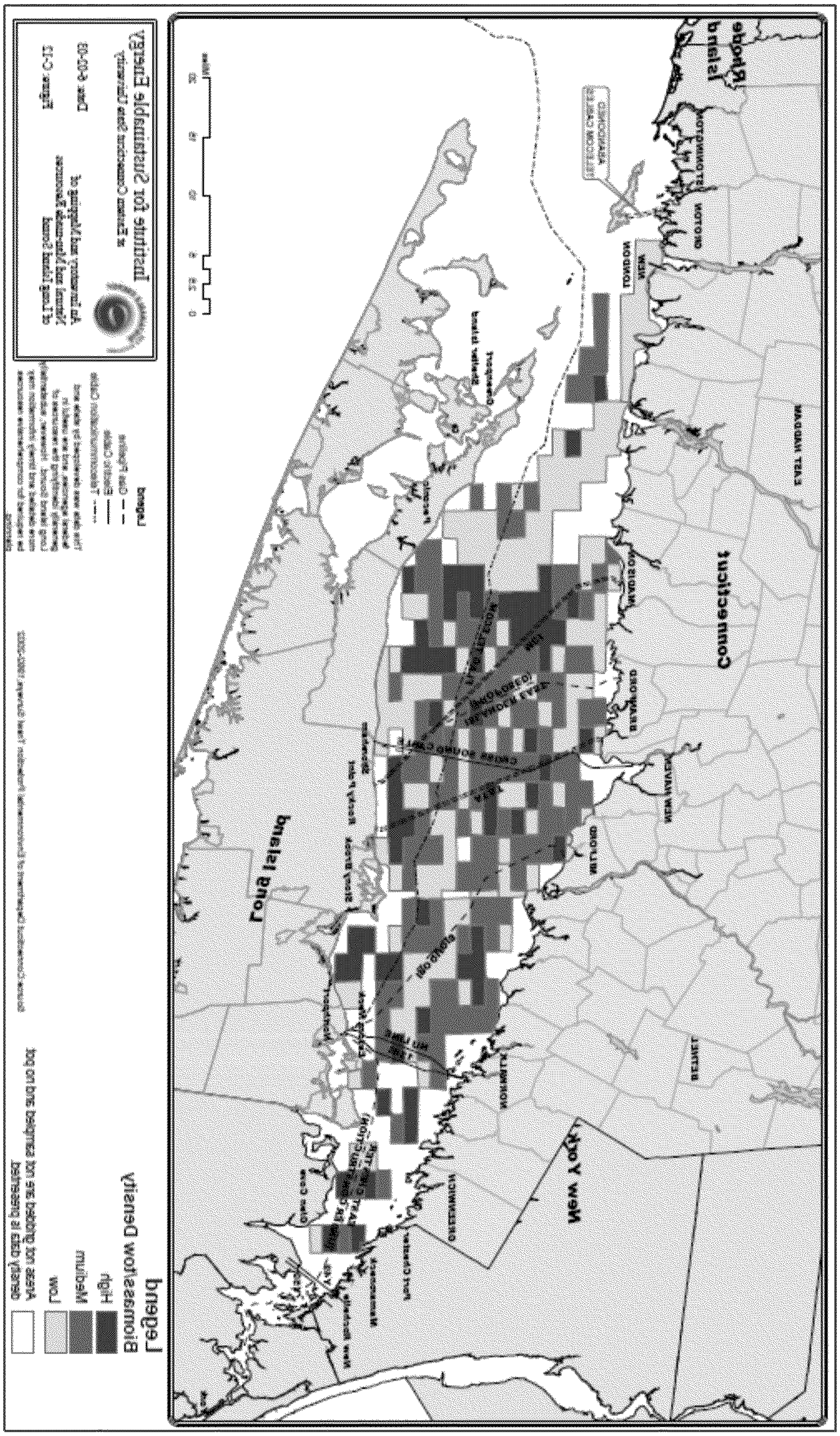


Figure 53. Finfish biomass/tow density, 1992-2002 (Institute for Sustainable Energy, 2003b).

ED_001437D_00000426-00088

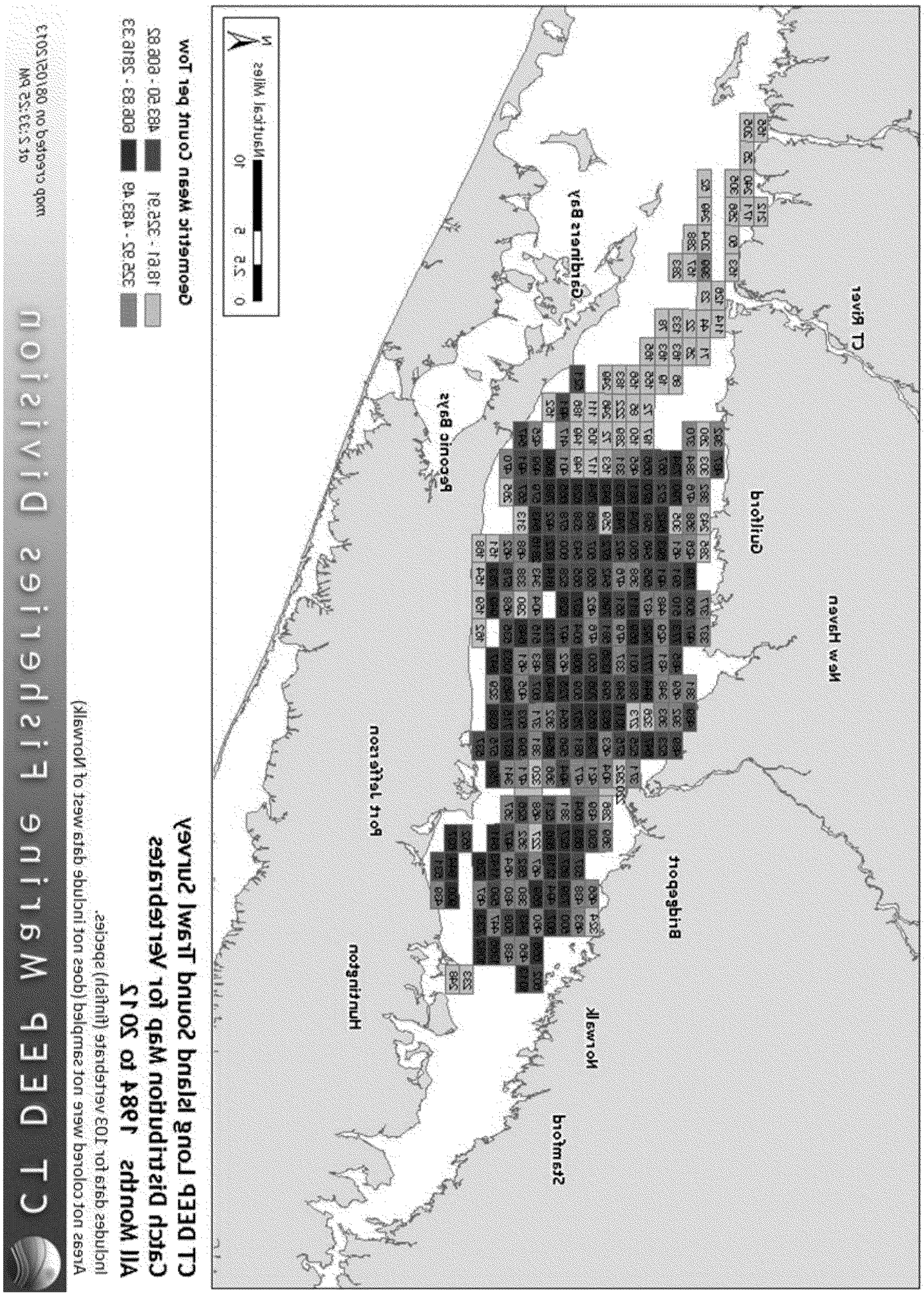


Figure 54. Finfish count per tow, 1992-2012 (CTDEEP, unpublished data, August 2013).

ED_001437D_00000426-00089

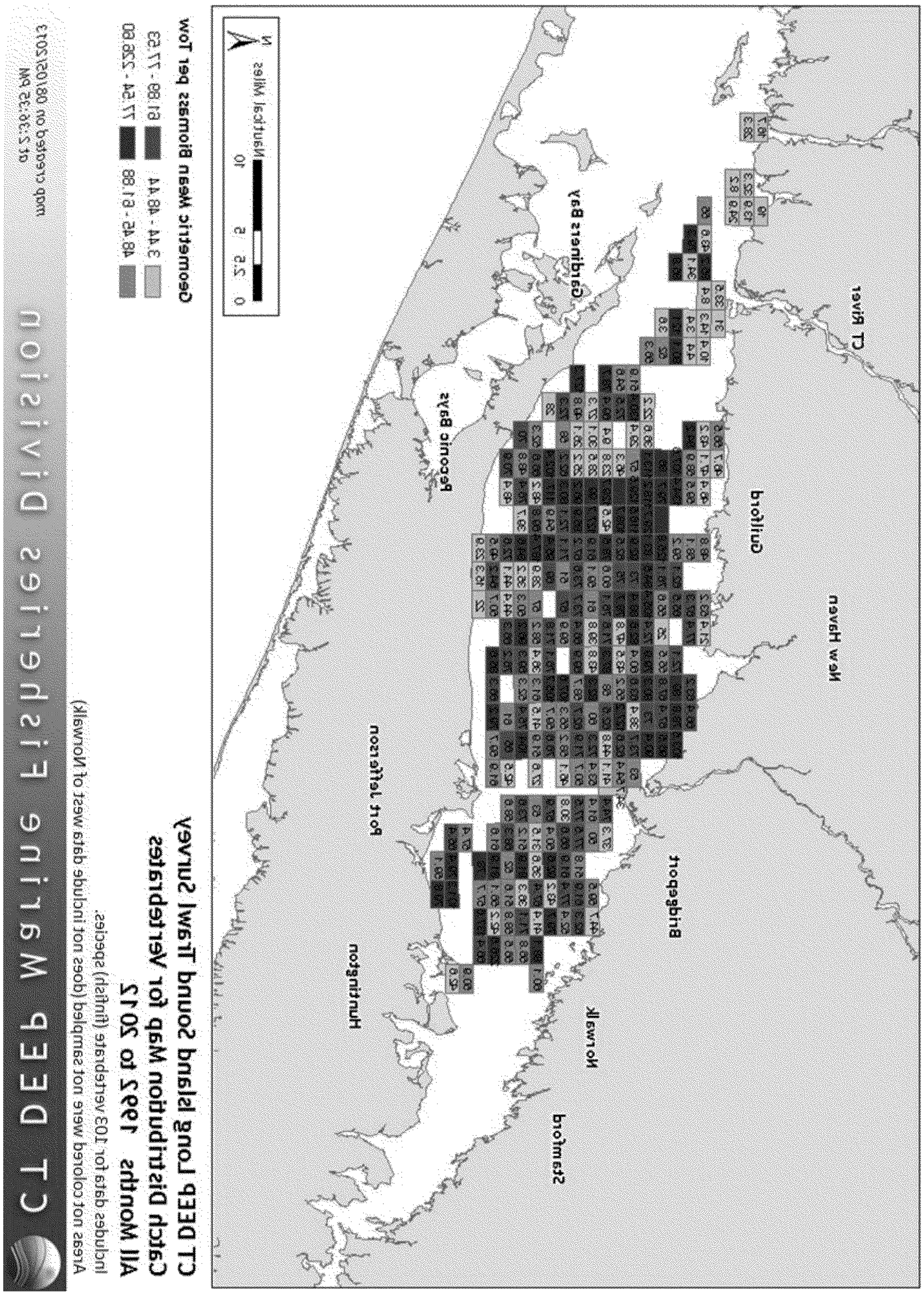


Figure 55. Finfish biomass per tow, 1984-2012 (CTDEEP, unpublished data, August 2013).

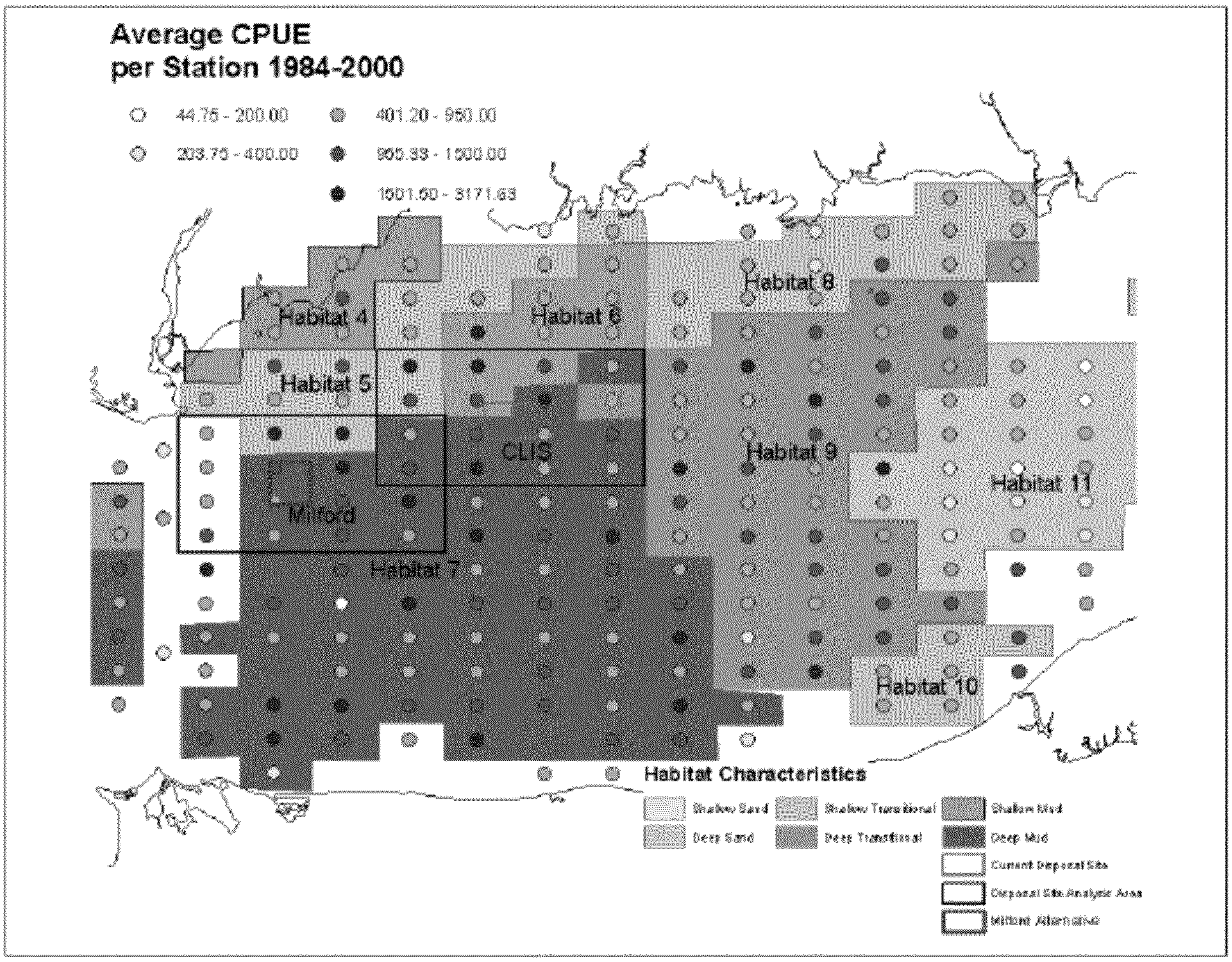


Figure 56. Average catch-per-unit-effort (CPUE) and substrate in CLIS, 1984-2000 (in USEPA and USACE, 2004).

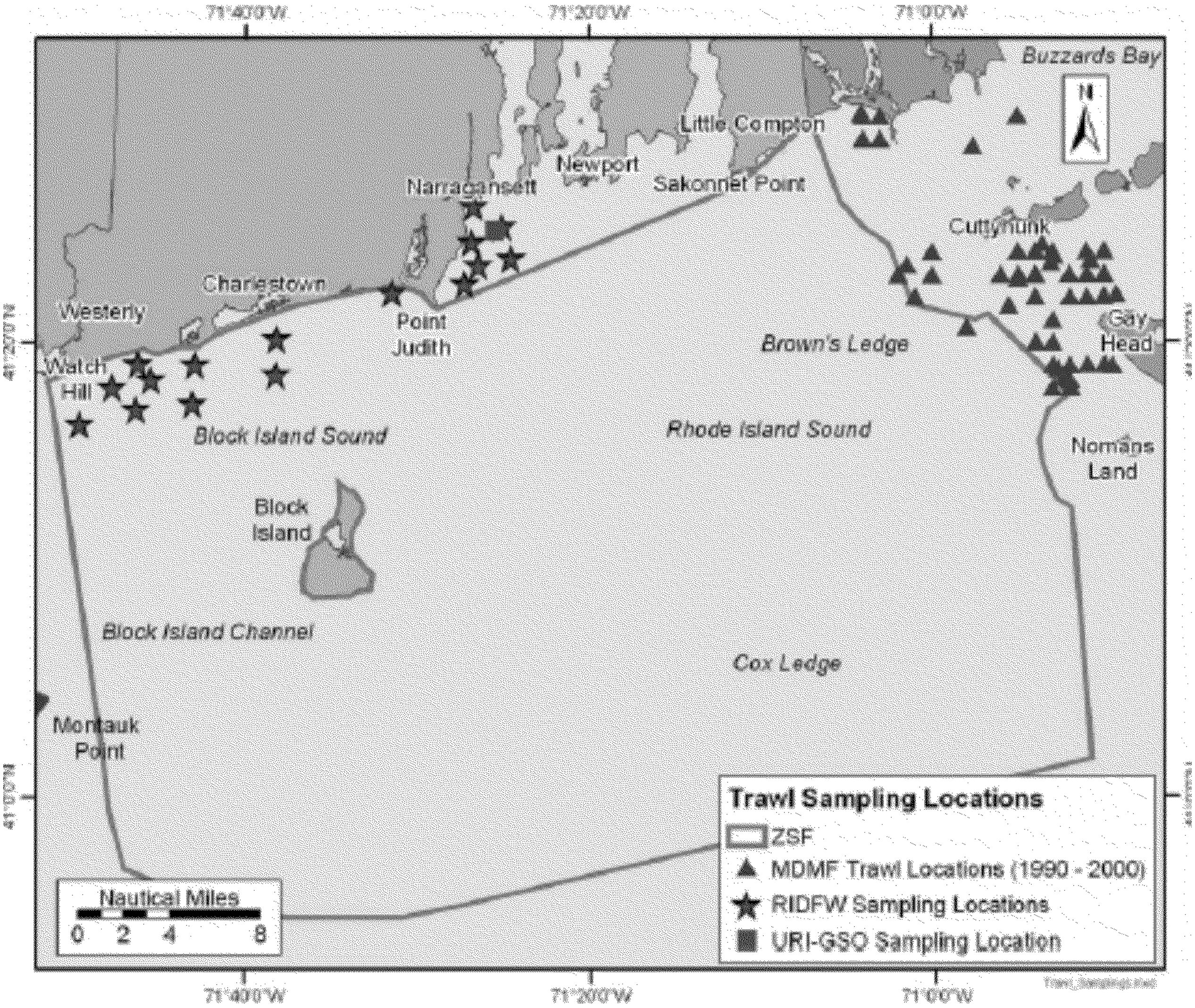


Figure 57. Fish trawl sampling data reviewed in the RIR EIS (USEPA and USACE, 2004b). Only the RIDFW survey locations are within the ZSF for the ELIS SEIS.

ED_001437D_00000426-00092

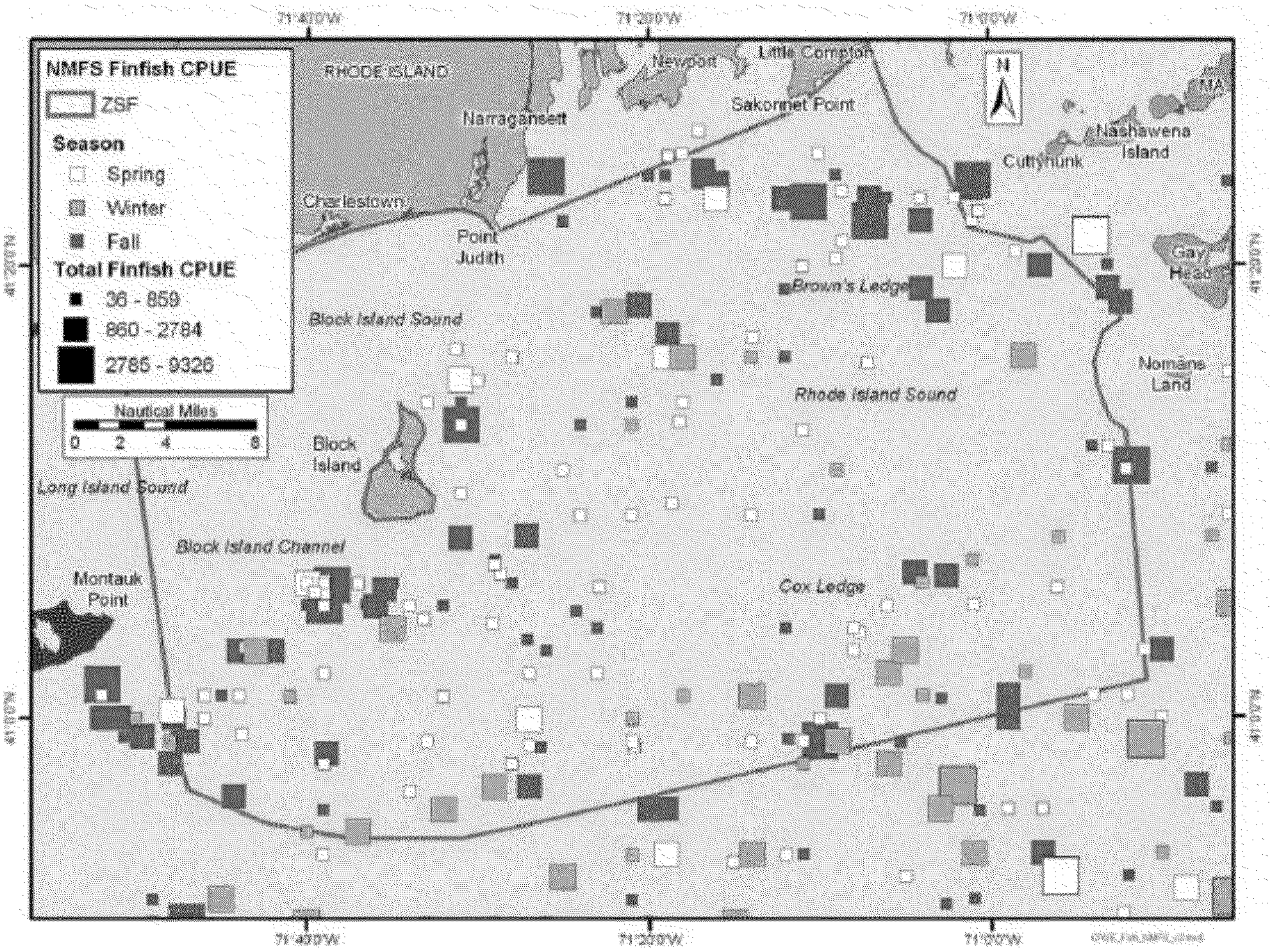


Figure 58. Distribution of finfish catch-per-unit-effort (CPUE) observed during NMFS trawl surveys in the fall, winter, and spring (1990–2002) (USEPA and USACE, 2004b).

ED_001437D_00000426-00093

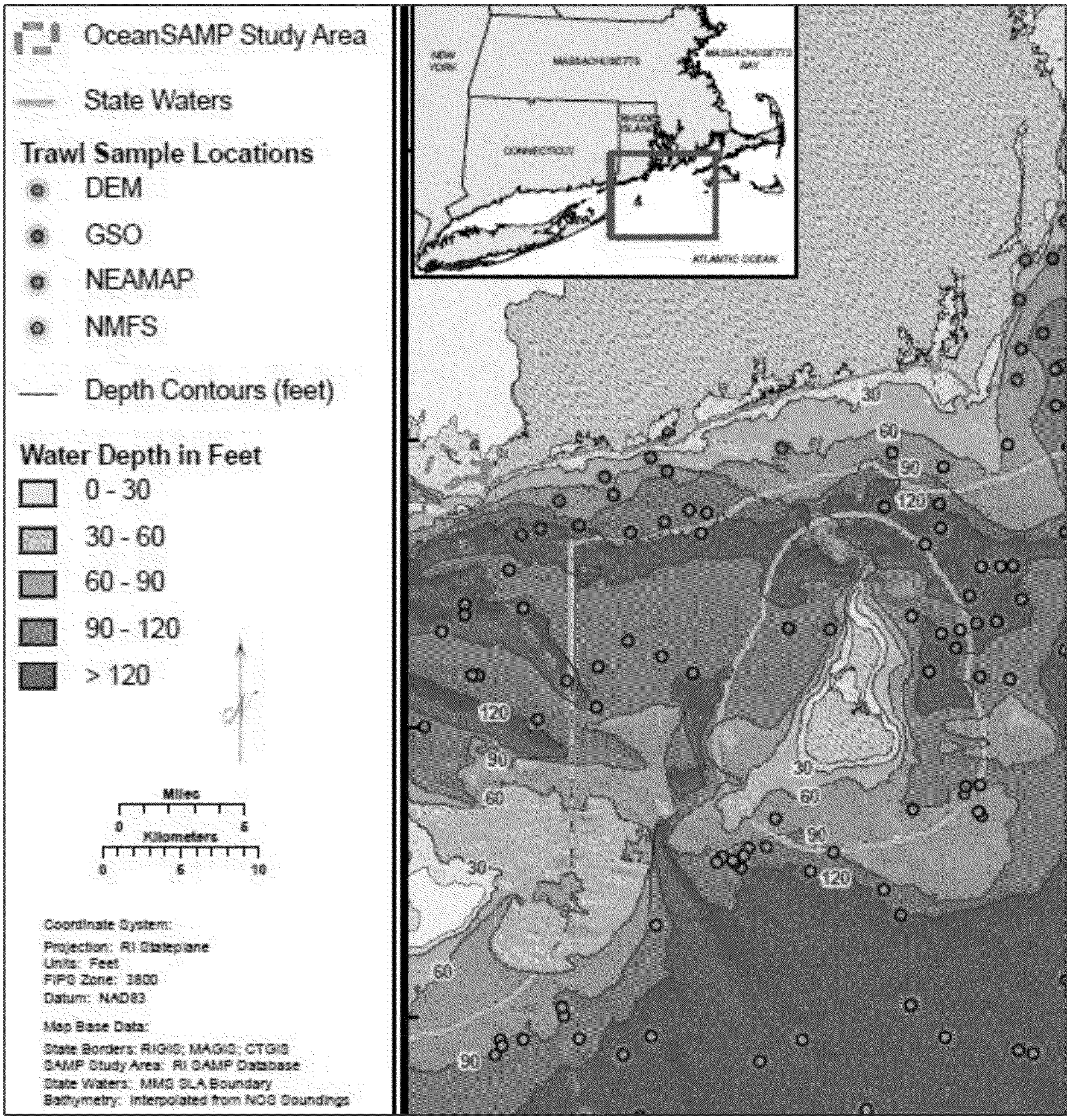


Figure 59. Trawl sample locations in BIS (RICRMC, 2010).

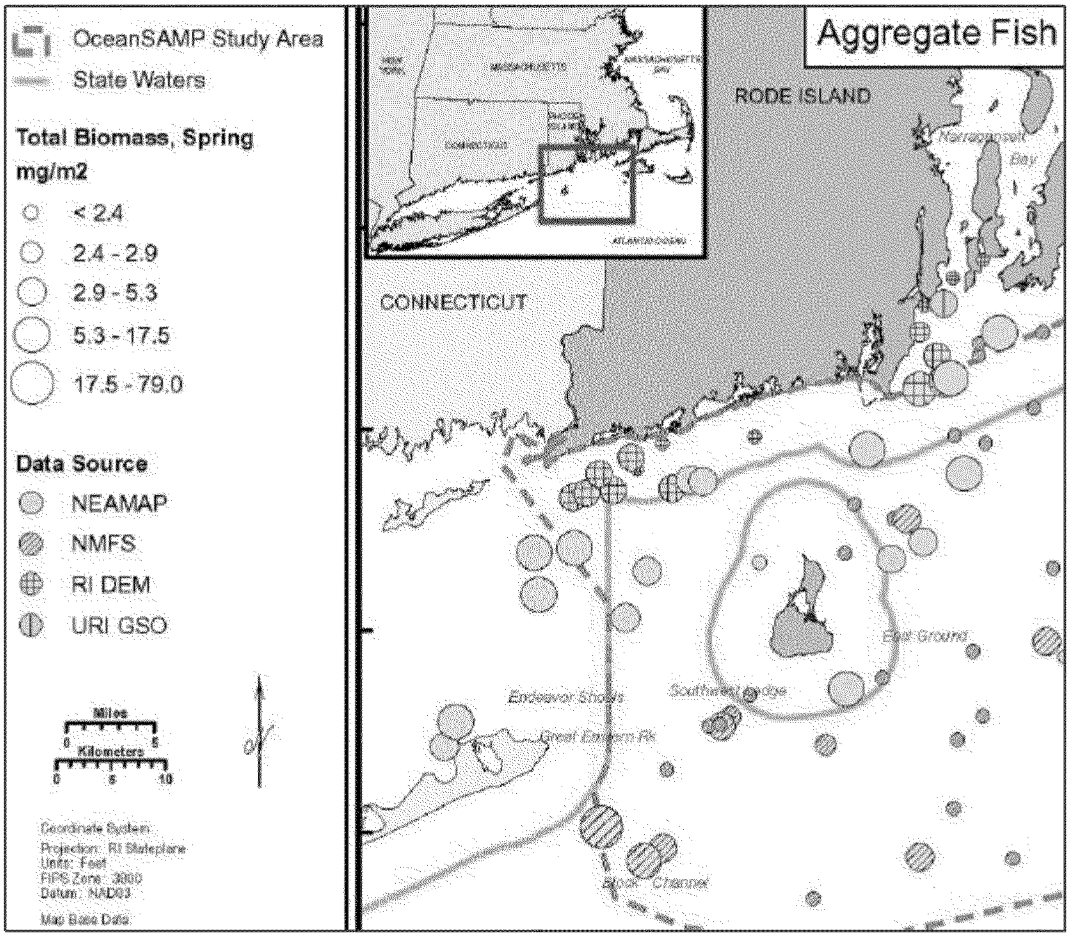


Figure 60. Aggregate fish biomass in BIS based on 1999 to 2008 data (RICRMC, 2010).

ED_001437D_00000426-00095

3.10.2 Essential Fish Habitat

Data Needs: Characterization of Essential Fish Habitat (EFH) in the ZSF, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1996, that has as its goal the sustainability of the nation's fishery resources through conservation of "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (62 F.R. 66551).

The Act authorizes NMFS to evaluate programs and projects that are proposed, permitted, or licensed by federal agencies that may adversely affect federally managed marine, estuarine, and anadromous finfish; mollusks; and crustaceans; or the habitats of these species. A dverse effects may be direct (*e.g.*, physical disruption of habitat) or indirect (*e.g.*, loss of prey species). N MFS may make recommendations regarding how to avoid, minimize, mitigate, or otherwise offset any adverse impacts to EFH. The EFH includes a full description of the proposed action and means of carrying it out, so that the potential impacts to EFH can be properly analyzed.

Existing Information: For the CLIS/WLIS EIS, the USACE conducted an EFH assessment for the entire LIS (USACE, 2001). The assessments identified 27 fish species with EFH designated in the project area for one or more life stages (adult, juvenile, larvae, or eggs):

Alewife, Blueback herring
American shad
Atlantic butterfish
Atlantic herring
Atlantic mackerel
Atlantic menhaden
Atlantic salmon
Atlantic sturgeon
Black sea bass
Bluefin tuna
Bluefish
Fourspot flounder
Hogchoker
King/Spanish mackerel, Cobia
Pollock
Red hake
Scup
Silver hake
Spotted hake
Striped bass
Summer flounder
Tautog
Weakfish
Windowpane flounder
Winter flounder

ED_001437D_00000426-00096

It also identified one crustacean (American lobster) and one mollusk (Long-finned inshore squid) with EFH designated in the project area.

An EFH analysis was also conducted for the Broadwater LNG EIS (FERC, 2008) covering the entire ZSF for the ELIS SEIS (Figure 61). Both studies are applicable for the ELIS SEIS. For the RIR EIS, the grids used for the EFH analysis were all located to the east of Block Island, thus outside of the ZSF for the ELIS SEIS.

Source documentation for species with designated EFH in the ZSF is available on-line via the Northeast Fisheries Science Center at: http://www.nefsc.noaa.gov/nefsc/habitat/efh/#list.

Potential Other Sources: The Magnuson-Stevens Act requires consultation among NMFS and federal agencies, which would provide up-to-date EFH information.

Data Gaps: The available information is expected to be adequate data for site screening and EFH assessments for alternative disposal site assessments in the SEIS.

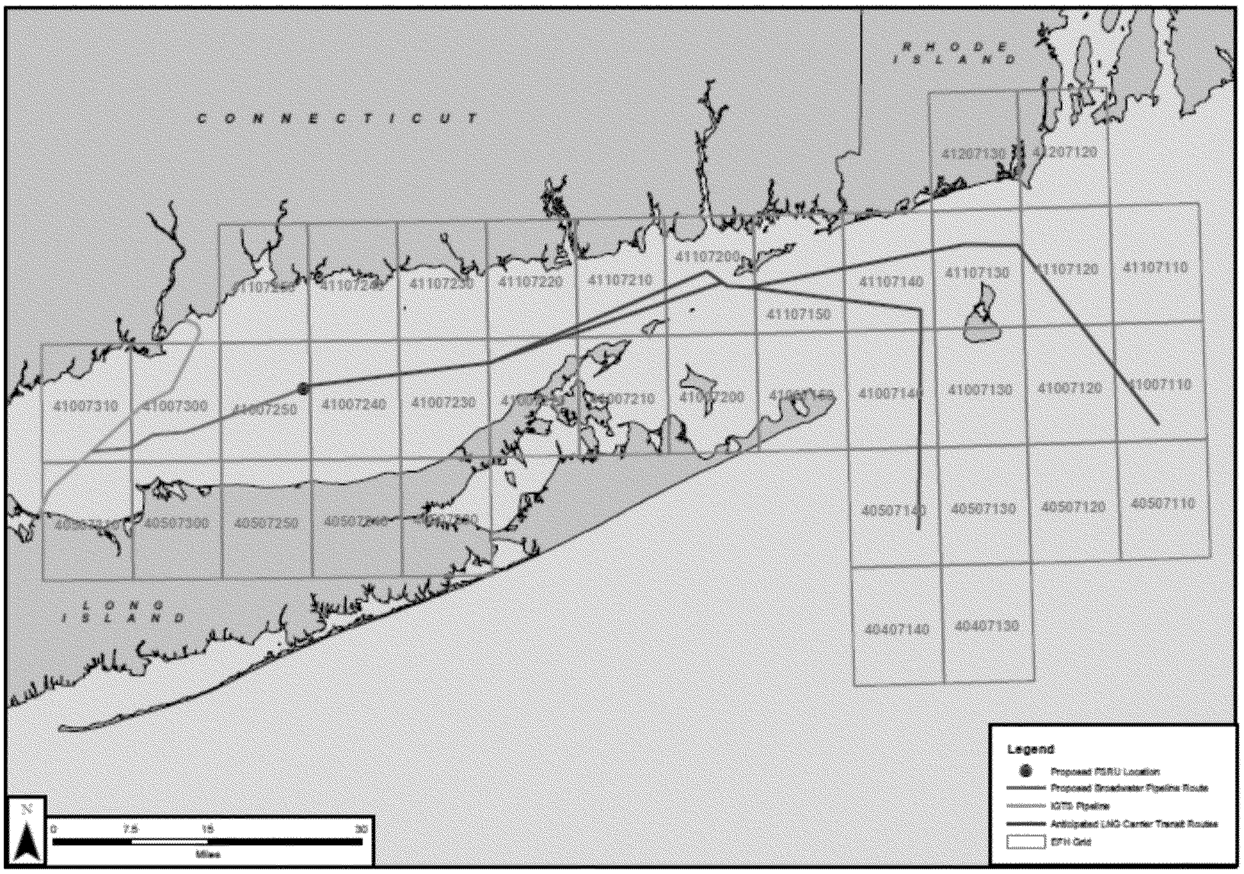


Figure 61. Study area for the Essential Fish Habitat assessment for the Broadwater LNG EIS (FERC, 2008).

3.11 Commercial and Recreational Shellfish Resources

Shellfish is a general term, which includes crustaceans (crab, lobsters) and mollusks (clams, oysters, scallops). Commercially and recreationally viable shellfish resources in LIS include bivalve mollusks (bay scallop, eastern oyster, northern quahog/hard clam, soft-shelled clam, and surf clam) and lobsters.

Lobsters feed and live on the sea floor and are comparatively mobile. They often live in dense "communities" in areas with either rocky substrates (rock, shell, etc.) for protection or mud substrates where they can burrow (CASE, 2004). Oysters have a free-swimming larval stage after which they attach to a hard substrate (shell, rock) for the remainder of their life. Clams also have a free-swimming larval phase after which they live within the top few inches of the sediment layer; their capability for lateral movement is very limited.

Data Needs: Information on commercially and recreationally viable shellfish resources, particularly their adult stages. While the types of shellfish resources in the ELIS are expected to be similar to CLIS/WLIS, their spatial distribution and abundance vary.

Existing Information: Shellfish bed information for the ZSF is integrated in Figure 62; these shellfish beds include oysters, clams, and scallops.

Trawl survey information collected by the CTDEEP (2012a) also includes data for American lobster and crabs. Figure 63 shows the invertebrate biomass from 1992 to 2012 for the entire LIS; dominant species were lobster, squid, various species of crab, as well as horseshoe crab. CTDEEP also conducts a lobster study, accompanying commercial lobster fishermen; the sampling area near New London is presented in Figure 64. Locations of lobster pots encountered by CTDEEP staff during trawl surveys up to approximately year 2000 are shown in Figure 65.

CTDEEP trawl data up to the year 2000 were synthesized in the CLIS/WLIS EIS. A general discussion of lobster and other shellfish resources is also included in the Broadwater LNG EIS. The RIS EIS includes a discussion of commercial and recreational shellfish resources, applicable also for BIS, although quantitative data (*e.g.*, density, CPUE, etc.) for BIS were not provided.

Recent data and studies for shellfish are important as annual variability affects data averages. For example, annual abundance catch totals of American lobster have decreased each year since the massive die-off in 1999 (Figures 66 and 67); therefore, the analysis of lobster data needs to consider the time of data collection in spatial comparisons. LIS lobster landings have decreased from over 10 million pounds in 1998 to only a few hundred thousand pounds in 2011. In Connecticut alone, lobster landings from LIS decreased from 3.7 million pounds in 1998 to just 142,000 pounds in 2011; the greatest decrease occurred in the western and central LIS where the decrease since 1998 has been 99% (CTDEEP, 2012b).

As listed in WHG (2010), Balcom and Howell (2006) and Pearce and Balcom (2005) reviewed American lobster mortality in LIS from 1999 to 2004 along with fishery landing information, habitat and water quality. The LISS (2008) included information on oyster/lobster/clam harvest

(1984-2007). Rhode Island's 2013 Management Plan for the Crustacean Sector provides information on stock status, including lobster abundance and landings since 1979, and lobster CPUE since 1991 (RIDFW, 2012b). Abundance data are also provided for cancer crab, blue crab, and horseshoe crab. The *Rhode Island 2013 Management Plan for the Shellfish Fishery Sector* for quahogs, soft-shell clams, whelk, and other shellfish listed information on commercial landings and an assessment of the resource (RIDFW, 2012c). New York State's Suffolk County provides information of their Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay (Suffolk County, 2013). Simpson (2005) provided a semi-annual performance report on assessing and monitoring the American lobster resource and fishery in Long Island Sound, including information from the CTDEEP LIS trawl survey and lobster tagging study, stock identification, and spatial analysis of habitat structure and distribution. U.S. Navy (1973) includes lobstering data from areas around Fishers Island, although data are considered outdated.

Considering the susceptibility of lobsters and shellfish to environmental stressors such as temperature, dissolved oxygen, and other factors (*e.g.*, Balcom and Howell, 2006), relevant information to be considered in the assessment of lobster resources is habitat information such as sediment texture and substrate morphology. Lobsters prefer rocky and firm mud substrates (LISS, 2013b), with a higher preferences for rocky surroundings (Barshaw and Bryant-Rich, 1988).

Other shellfish abundances also vary temporally. As stated in CASE (2004), oyster harvesting dropped from approximately 600,000 to 250,000 bushels/year from 1996 to 2000 because of the parasite MSX. On the other hand, clam harvesting increased from 150,000 to over 250,000 bushels/year in the same time period.

Potential Other Sources: Current databases at NMFS, state agencies (RIDFW, CTDEEP, NYSDEC), and universities (UCONN, URI, SUNY Stony Brook).

Data Gaps: For the ELIS, the existing information and the CTDEEP fish trawl database are expected to be adequate for characterizing overall shellfish resources in the ELIS. However, given the temporal and spatial variability of shellfish resources of time, and its susceptibility for storms, the data are likely not sufficient to characterize alternative disposal sites, and may require selected field surveys (assuming the lobster density is expected to be sufficiently abundant) and/or queries of shell fishermen. In addition, considering the susceptibility of lobsters and shellfish to environmental stressors such as temperature, dissolved oxygen, parasites, and other factors, the dates of past survey results are relevant.

For BIS, additional data would need to be obtained (from 'Potential Other Sources' listed above) and reviewed to determine potential data gaps both for BIS in general, and for the potential alternative disposal sites. Specifically, the three deep holes south of Fishers Island may contain unique shellfish habitats. In addition, information about shellfish resources in the area north of Montauk was not located.

ED_001437D_00000426-00099

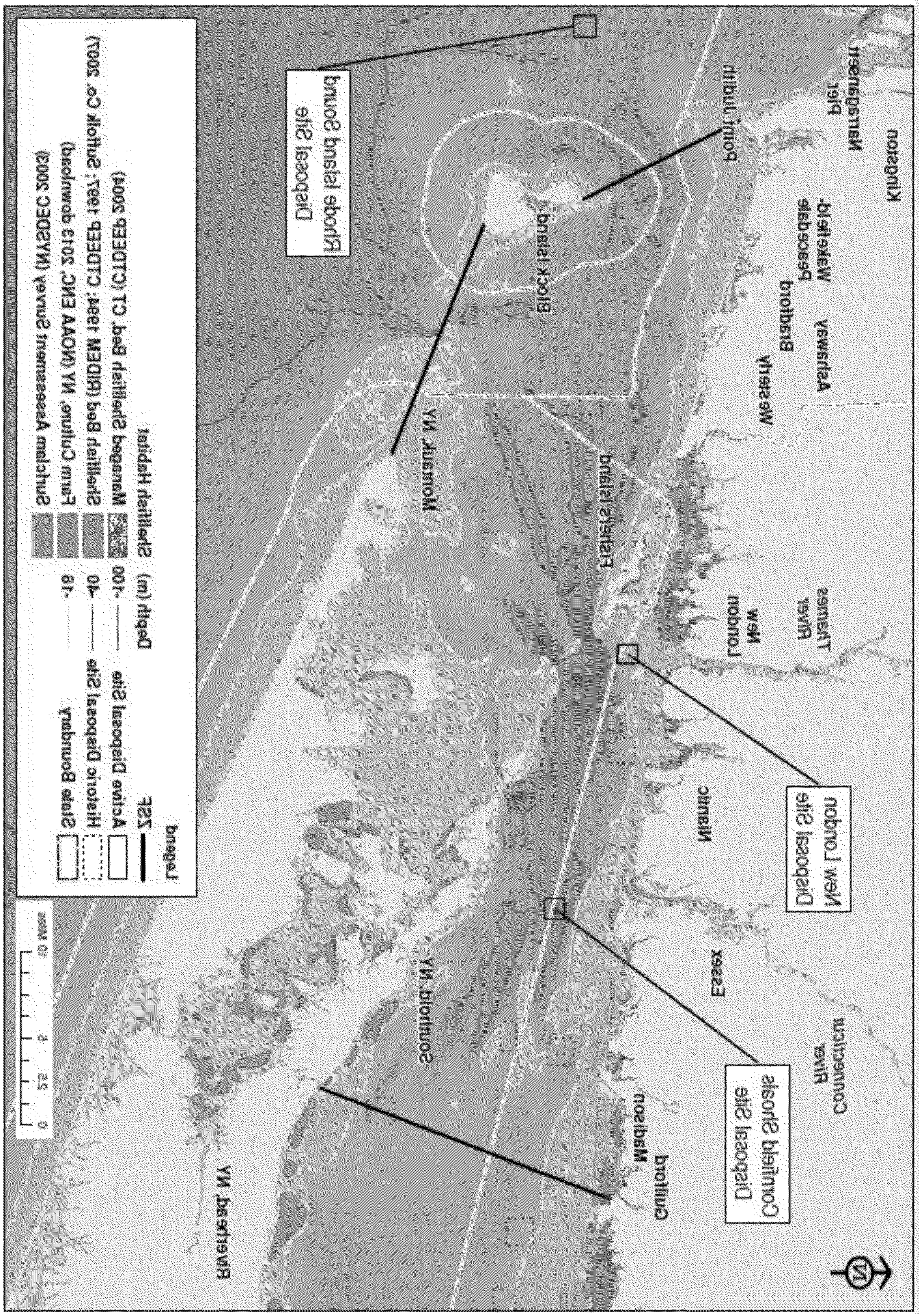


Figure 62. Shellfish beds in the ZSF (GIS compilation; June 23, 2013).

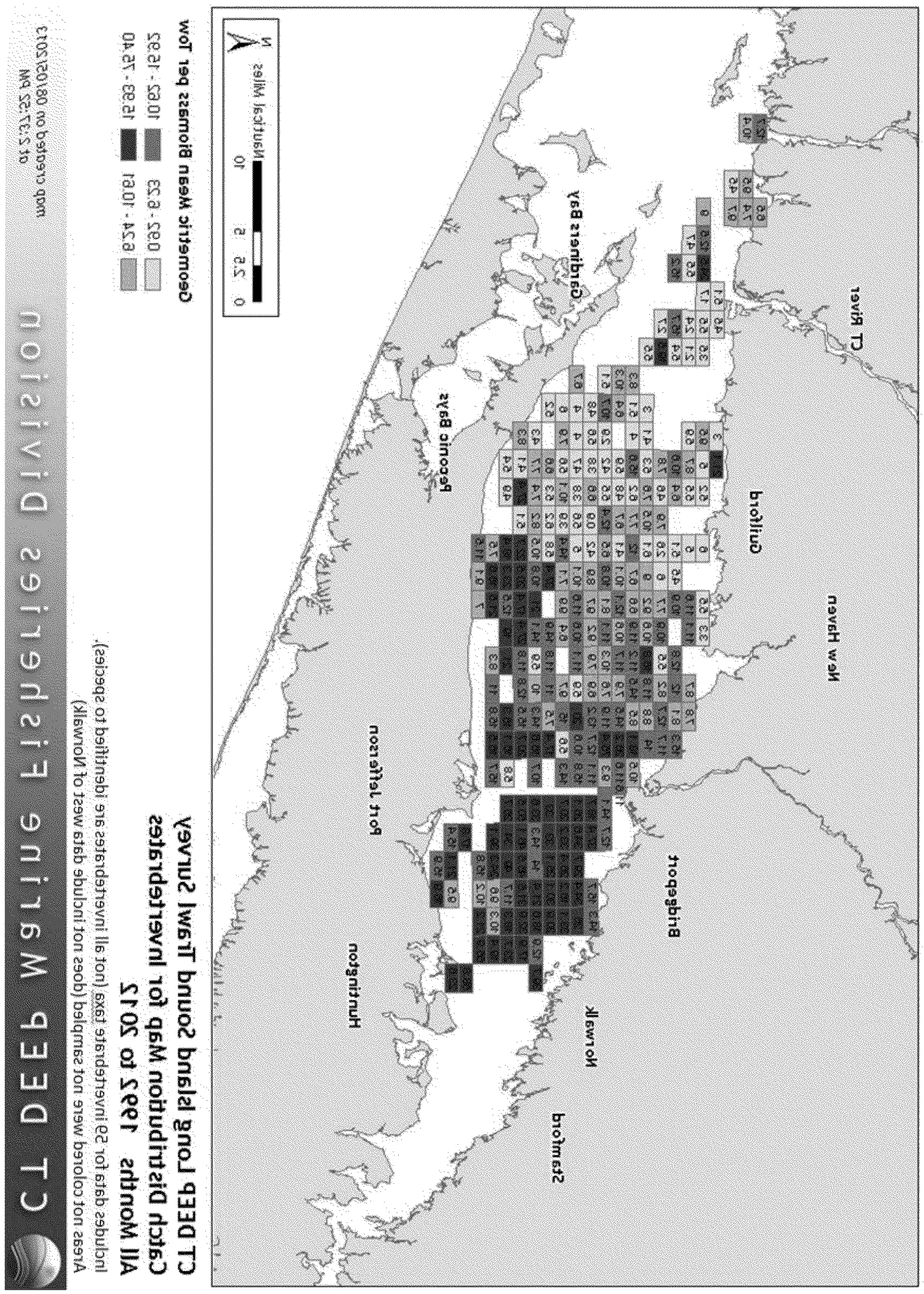


Figure 63. Invertebrate biomass per tow, 1992-2012 (CTDEEP, unpublished data, August 2013). Invertebrate species consist predominantly of lobster, squid, horseshoe crab, and several other species of crab).

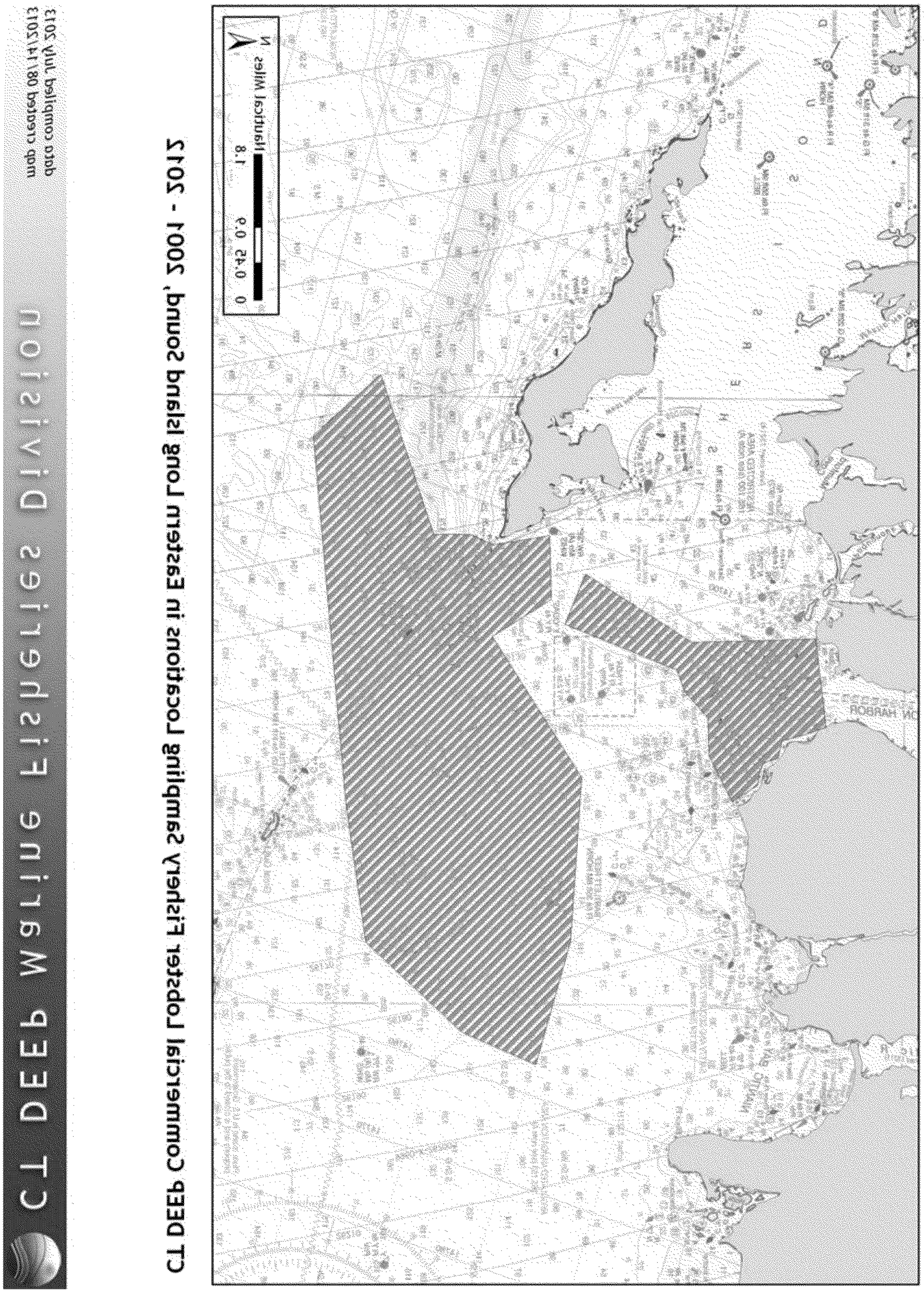


Figure 64. Commercial lobster fishery sampling locations in the New London area of ELIS, 2001-2012.

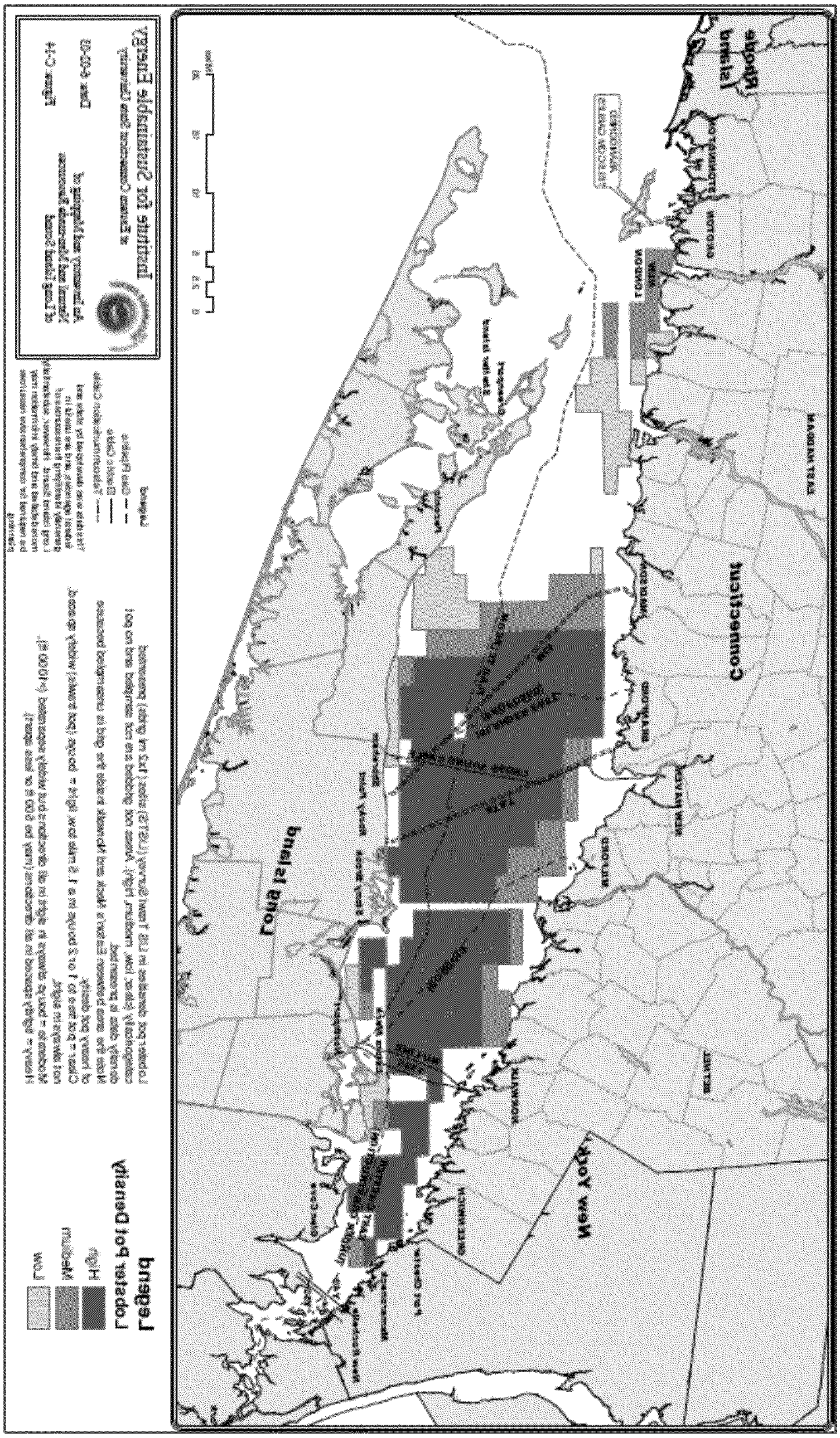


Figure 65. Lobster pot densities observed by CTDEEP staff during trawl surveys (Institute for Sustainable Energy, 2003b). Note: Years of data represented in the graph not yet known.

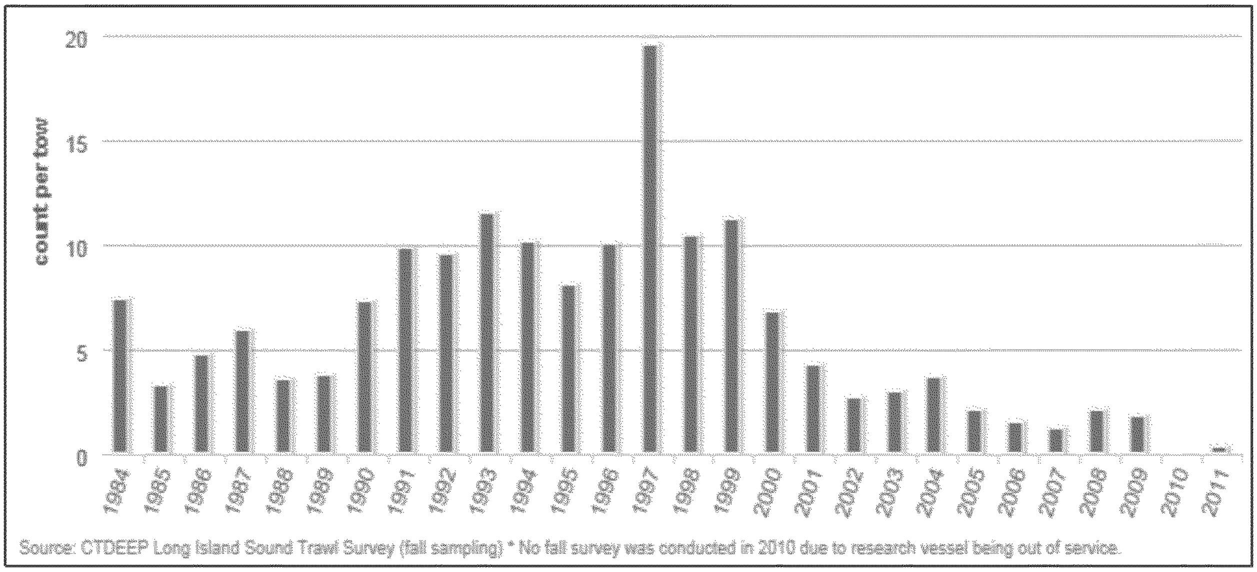


Figure 66. Lobster abundance in LIS, based CTDEEP's fall trawl survey, 1984 to 2011 (LISS, 2013b).

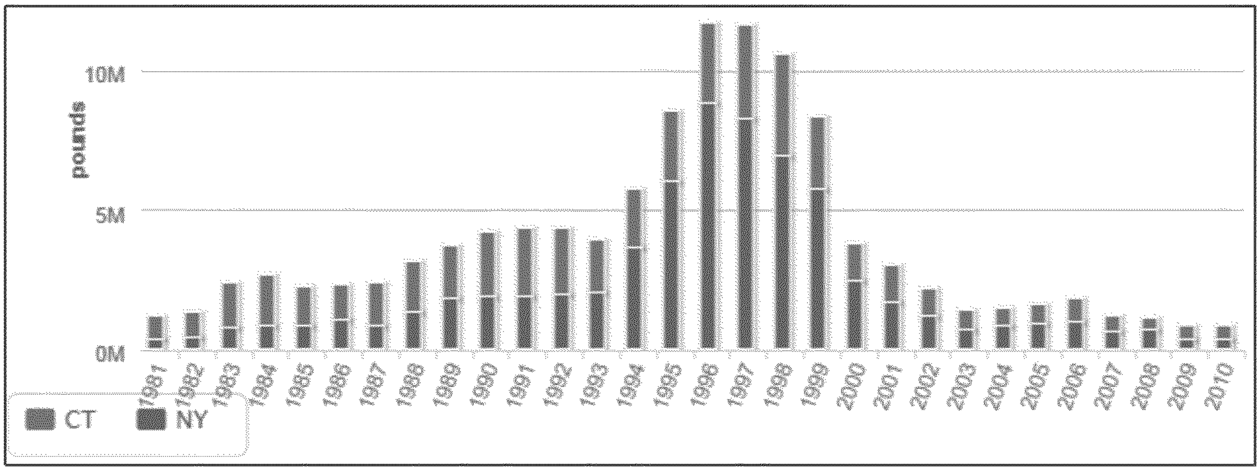


Figure 67. Lobster landings in LIS, 1981 to 2010 (LISS, 2013b).

3.12 Birds, Marine Mammals, Reptiles, and Endangered and Threatened Species

Data Needs: Information for the ZSF on local coastal and marine birds, marine mammals, reptiles, and endangered and threatened species, whose survival might be impaired by the proposed activity, particularly at selected alternative disposal sites.

Existing Information: The CLIS/WLIS EIS provided a comprehensive overview of coastal and marine birds, marine mammals, reptiles, and endangered and threatened species in the entire LIS that is considered applicable to the ELIS. The RIR EIS also addressed these species; although western BIS was not cove red by this study, the mobility and spatial range of these organisms allow for general extrapolation of information to the western BIS. The Broadwater LNG EIS (2008) spanned both LIS and BIS, although it discussed these organisms in less details than the two EIS documents.

WHG (2010) identified other documents that provide additional information on these animals. The Long Island Sound Study (LISS, 2008) provide d a status report on a range of environmental issues pertaining to LIS, which includes these animals. The Institute for Sustainable Energy (2003a,b) provided information on the general distribution areas in LIS for Atlantic whitesided dolphin, gray seal, harbor seal, hooded seal, humpback whale, marine turtles, and sensitive bird habitats and nesting sites in Connecticut waters. NOAA 's geodatabase for the Environmental Sensitivity Index (NOAA, 2002) contains information on bird nesting/foraging/rafting sites, marine mammal distribution and seal haul-out sites, and reptile concentration and nesting areas. The three states maintain lists of endangered, threatened and special concern species for mammals, birds, reptiles, amphibians, fish, insects, and plants (*e.g.*, CTDEEP, 2010).

The Rhode Island SAMP (RICRMC, 2010) provided relevant information on marine mammals, reptiles and birds for BIS, which included, for example, modeled seasonal relative abundance patterns for cetaceans (whales, dolphins, porpoises; *e.g.*, Figure 68) and leatherback turtles, as well as offshore wildlife viewing areas (birds, whales, sharks; Figure 69).

Connecticut Sea Grant (year not provided; WHG [2010]) provided a listing of invasive species in LIS, including descriptions, pathway of invasion, current distribution, and impact. Species included bread-crumb sponge, orange striped anemone, common periwinkle, European flat oyster, Asian shore crab, green crab, kelp bryozoan, compound sea squirt, Asian stalked tunicate, sea grape, compound tunicate, golden star tunicate, red alga, Dead man's fingers, lionfish, and mute swan.

Potential Other Sources: Additional recent information may be available from the Audubon Society, the Federation of New York State Bird Clubs, CTDEEP, NYSDEC, RIDEM, USFWS, and NMFS.

Data Gaps: Information is considered adequate for site screening for ELIS and BIS. For the assessment of alternative disposal sites, the CLIS/WLIS EIS information should be updated through further literature review, as appropriate. For western BIS, specifically the ar ea north of

Montauk, more detailed information should be obtained, as appropriate, as the area was outside the ZSF for the RIR and CLIS/WLIS EISs. The USFWS database should be accessed for updated information on endangered and threatened species in Connecticut, New York, and Rhode Island.

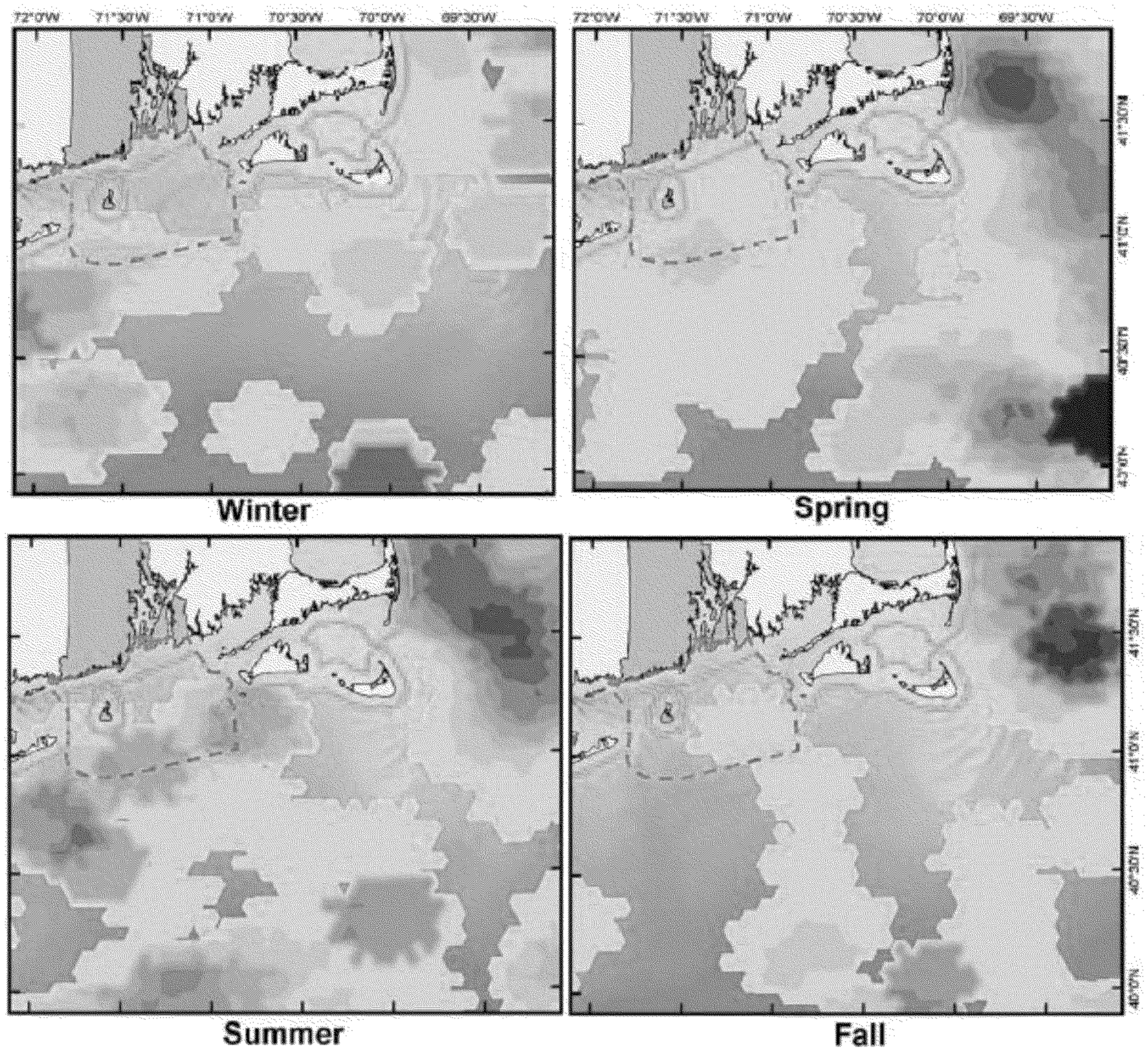


Figure 68. Modeled seasonal relative abundance patterns of fin whales in the Ocean SAMP area (RICRMC, 2010). The darker the color, the greater the relative abundance.

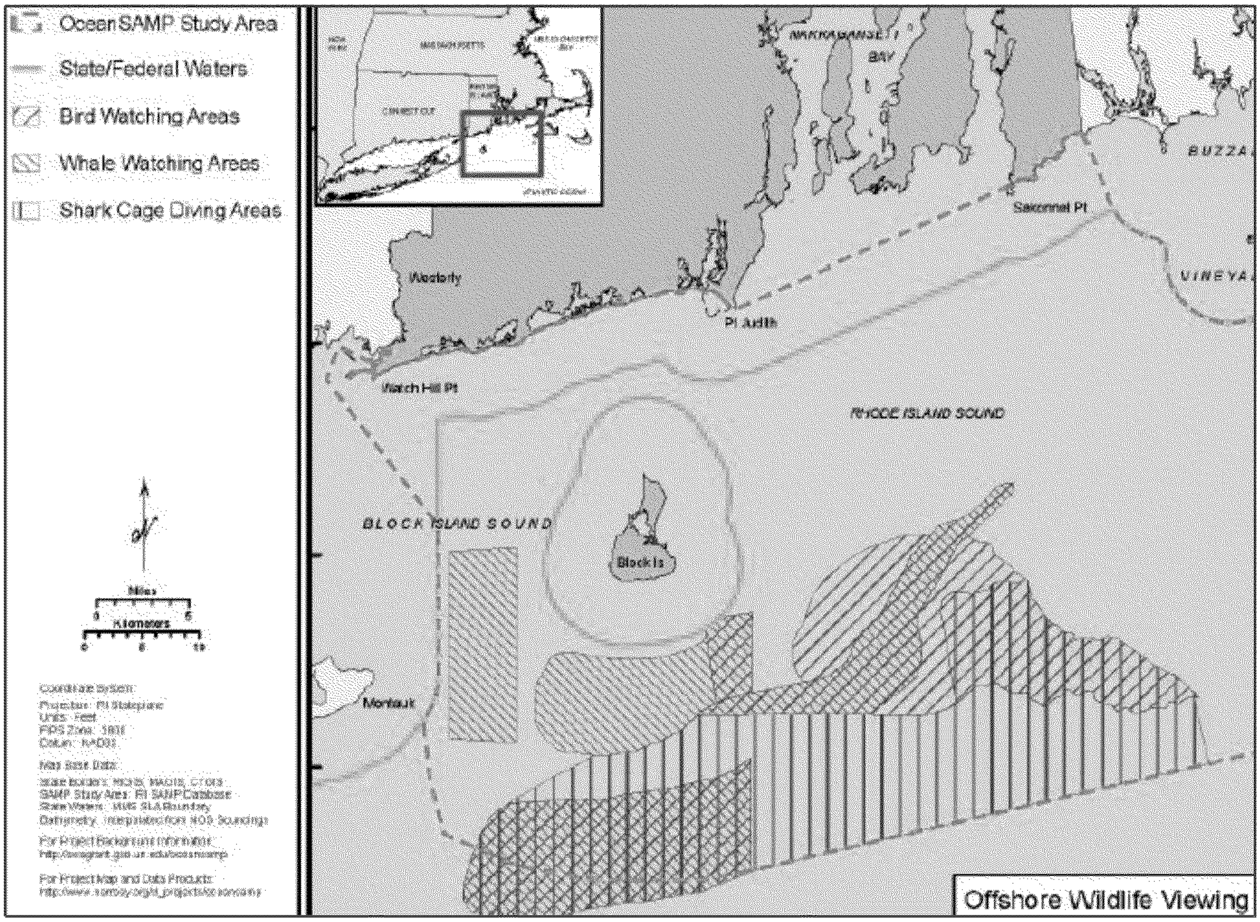


Figure 69. Map of offshore wildlife viewing areas (RICRMC, 2010).

ED_001437D_00000426-00107

3.13 Contaminant Levels in Selected Species

Data Needs: Tissue analysis data for finfish, lobsters, clam and worms, as well as information on ecological and human health risks.

Existing Information: WHG (2010) lists three references about contaminant concentrations in organisms in LIS. Stacey and Beristain (1990) described contaminants of concern in the LIS, the potential contaminant sources and their fate and transport in the LIS, and the effects on the environment and human health. Mitch (2006) compiled data on contaminant (metals, PCBs, pesticides, PAHs) concentrations in the water column, sediments, and biota from 1994 through 2005. Specific station locations for the data were not included, and an understanding of spatial differences within the ZSF would require review of source documents used by Mitch (2006), considering the spatial variability in sediment texture in the ELIS.

Skinner et al. (2009) reported results of a bi-state (Connecticut and New York) study, supported by the USEPA, to update data on chemical residues in important fisheries, and in fisheries with existing health advisories or having a significant potential for health advisories. Specifically, the study analyzed striped bass, bluefish, weakfish, American eels, and American lobster (hepatopancreas only) for PCBs and mercury, as well as cadmium and chlorinated dioxins and furans (lobster only). The study area was divided into four segments (Figure 70). Samples were collected in 2006 and 2007 using trawls, angling, lobster pots, and eel pots. The study examined the influence of year and season of collection, length, sex, and spatial distribution on chemical residue concentrations.

The current health advisories for CT, NY, and RI are as follows: The Connecticut Department of Public Health (CTDPH) advises not to eat bluefish (longer than 25 inches) and striped bass, and to limit consumption of bluefish (shorter than 25 inches) and weakfish, due to PCBs in fish tissue (CTDPH, 2013). The New York State Department of Health (NYSDOH) advises to limit consumption of weakfish, bluefish, American eel, and striped bass from LIS, BIS, and Peconic Bay due to PCBs in fish tissue. It further advises not to eat crab or lobster tomalley due to PCBs, dioxin, and cadmium (NYSDOH, 2013). The Rhode Island Department of Health (RIDOH), Office of Food Protection , advises to a void eating bass, pike, tilefish, king mackerel fish, and pickerel, swordfish, and shark, due to mercury, as well as bluefish and striped bass due to PCBs ; the consumption of black crappie and eel should be limited (RIDOH, 2013).

For the WLIS/CLIS EIS, s ite-specific analyses were performed on tissues from lobster, finfish, clams, and worms as a basis for human health and ecological risk analyses.

Potential Other Sources: University researchers.

Data Gaps: Available information is expected to be adequate for the ZSF, although site-specific information may be needed for selected alternative disposal sites, specifically for sites with fine-grained substrates such as the New London Disposal Site. This data need should be assessed further after review of the chemical data obtained during field studies in 2013.

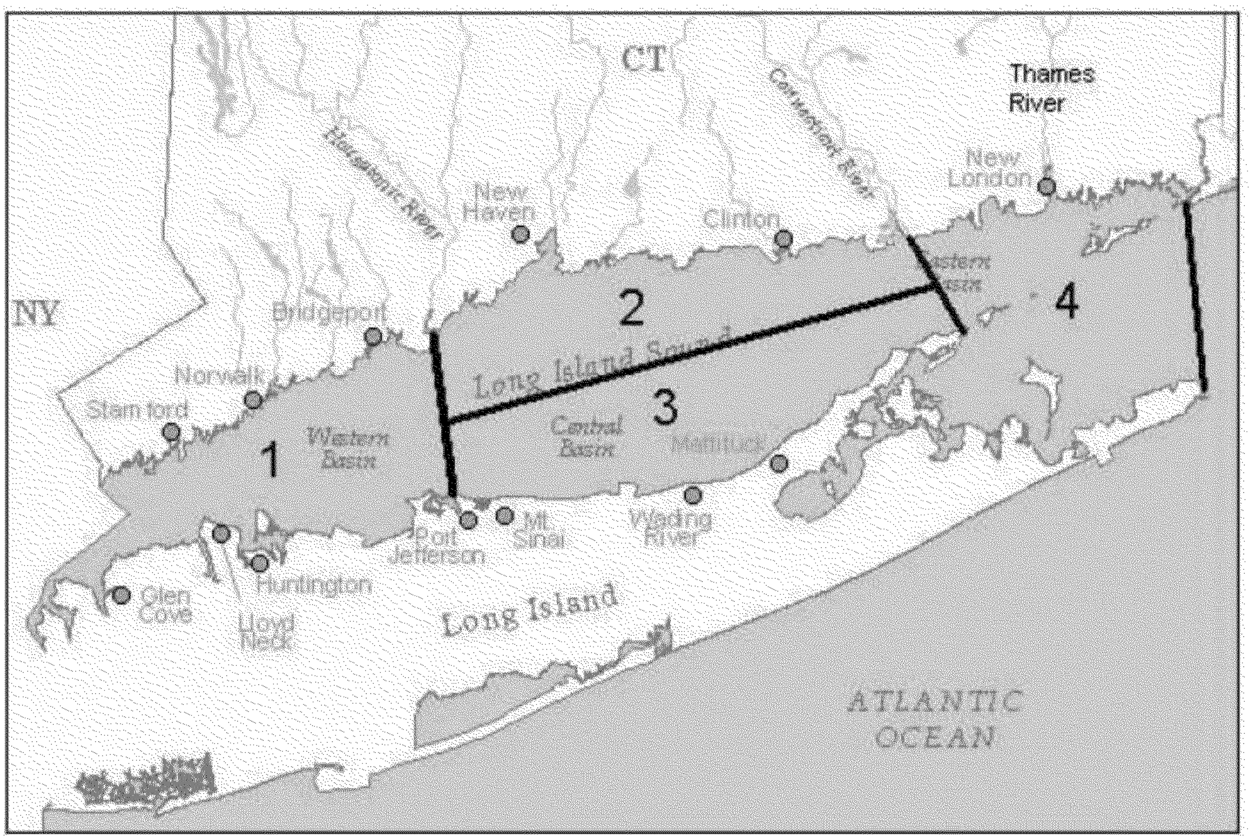


Figure 70. Chemical residue study area, separated into four segments (Skinner et al., 2009).

3.14 Socioeconomic Environment

3.14.1 Commercial and Recreational Fishing

Data Needs: Information that provides a general understanding of the value of commercial and recreational fishing in the ZSF, as well as at potential alternative disposal sites.

Existing Information: The NMFS collects data on annual landings by species. Some of the information included in the CLIS/WLIS EIS, such as landings, pertain to the entire LIS. The Broadwater LNG EIS only provided a brief overview of the types of commercial and recreational fishing. The RIR EIS provided summary fishing data for its entire ZSF, thus data cannot be directly used for just BIS.

Many of the references listed above in Section 3.10 (Finfish Resources) and Section 3.11 (Commercial and Recreational Shellfish Resources) are expected to contain relevant information on commercial and recreational fishing. For example, the *2013 Management Plans for the Finfish, Crustacean, and Shellfish Sectors* for Rhode Island provided information on scup, summer flounder, tautog, striped bass, black sea bass, winter flounder, bluefish, menhaden, monkfish, cod, lobster, cancer crab, blue crab, horseshoe crab, quahogs, soft-shelled clams, whelk, and other shellfish (RIDFW, 2012a,b, c). New York State's Suffolk County provides information on their Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay (Suffolk County, 2013; Figure 71).

Commercial and recreational fishing information for BIS, prepared by the SAMP (RICRMC, 2010), is summarized in Figure 72. Historic trawling information in BIS is presented in Figure 73, based on data in Olsen and Stevenson (1975).

Existing shellfish zoning in the ZSF is presented in Figure 74.

Potential Other Sources: Current databases at NMFS and state agencies (*e.g.*, RIDFW; NYSDEC; CTDEEP; Connecticut Department of Agriculture, Bureau of Aquaculture and Laboratory; Connecticut Seafood Council).

Data Gaps: Available data are expected to be sufficient to characterize the commercial and recreational fishing resources in the ZSF; however, for potential alternative disposal sites, additional information may be required through selected inquiries of commercial and/or recreational fishermen that fish in specific locations of interest.

ED_001437D_00000426-00110

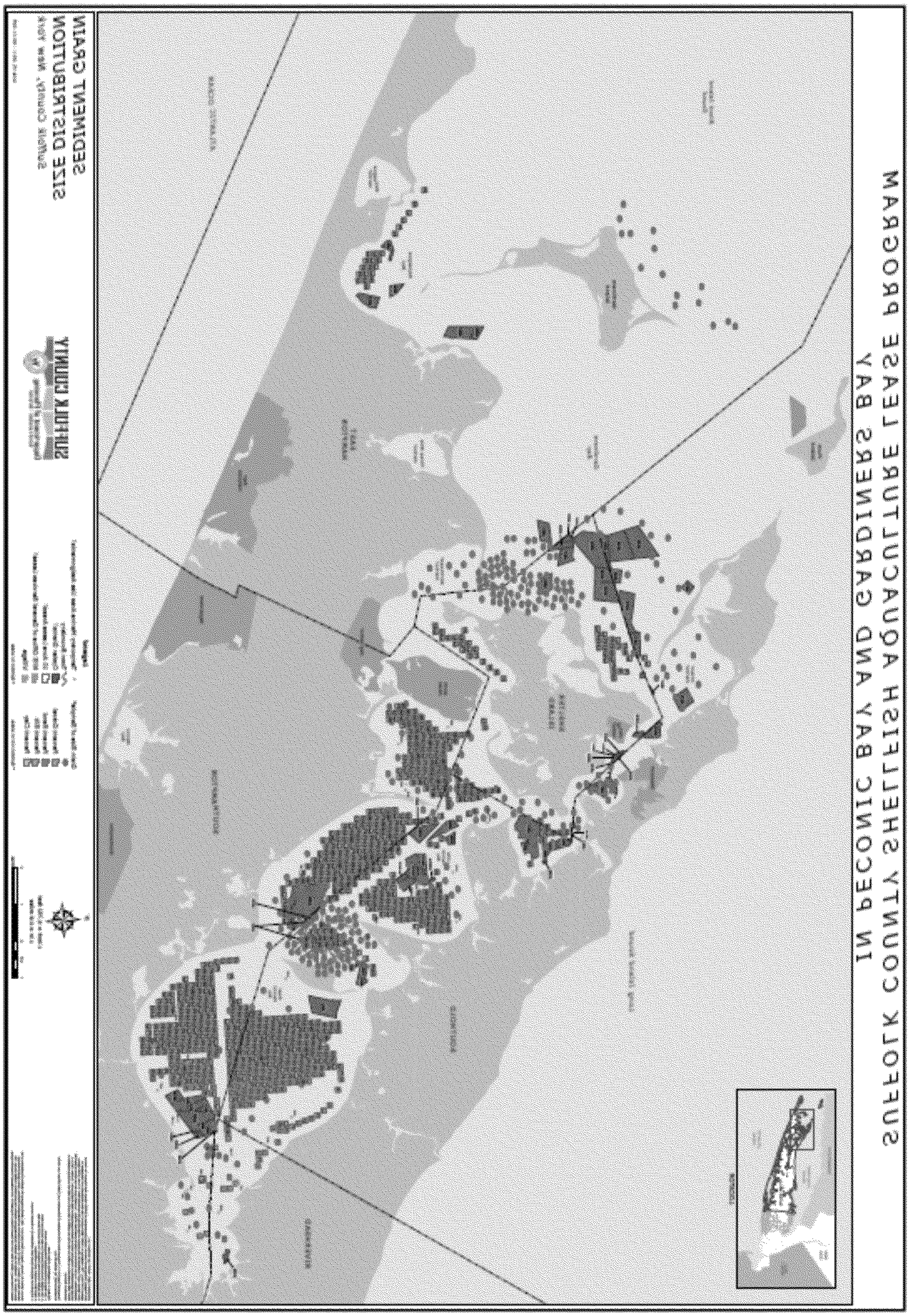


Figure 71. Suffolk County Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay (Suffolk County, 2013).

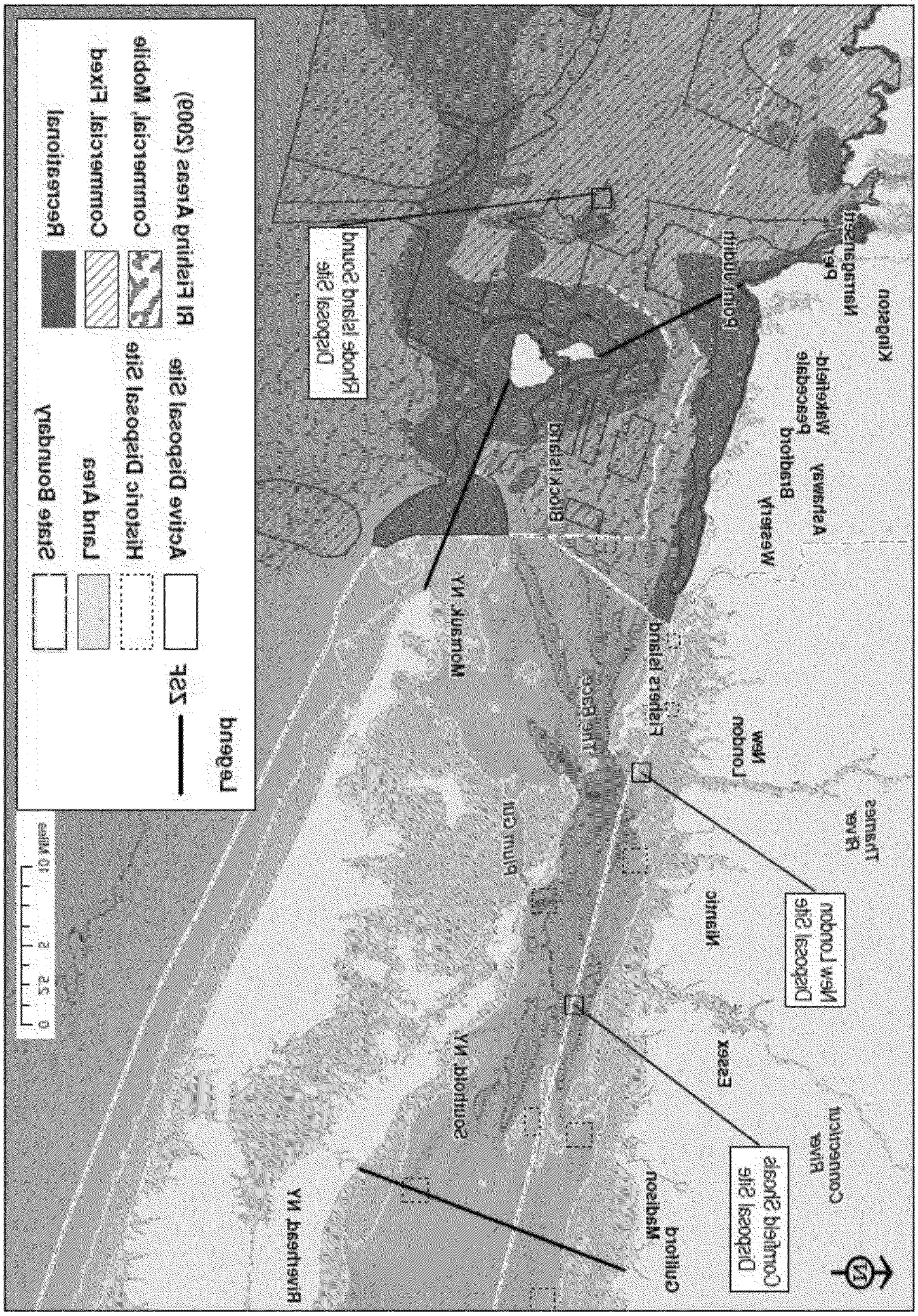


Figure 72. Commercial and recreational fishing in Rhode Island waters in the ZSF (GIS compilation; June 23, 2013).

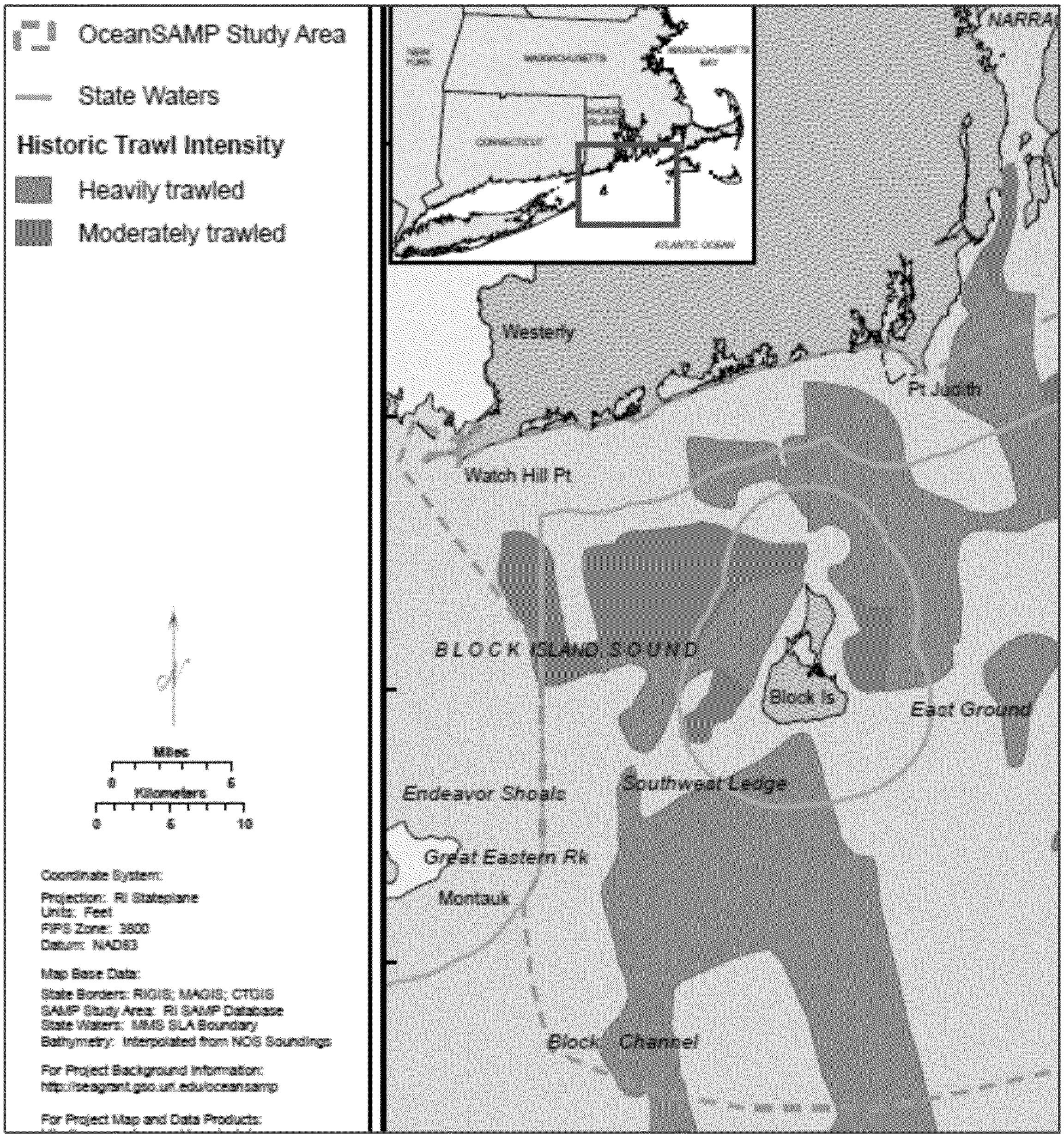


Figure 73. Historic trawling areas in BIS (RICRMC, 2010, based on data in Olsen and Stevenson, 1975)

ED_001437D_00000426-00113

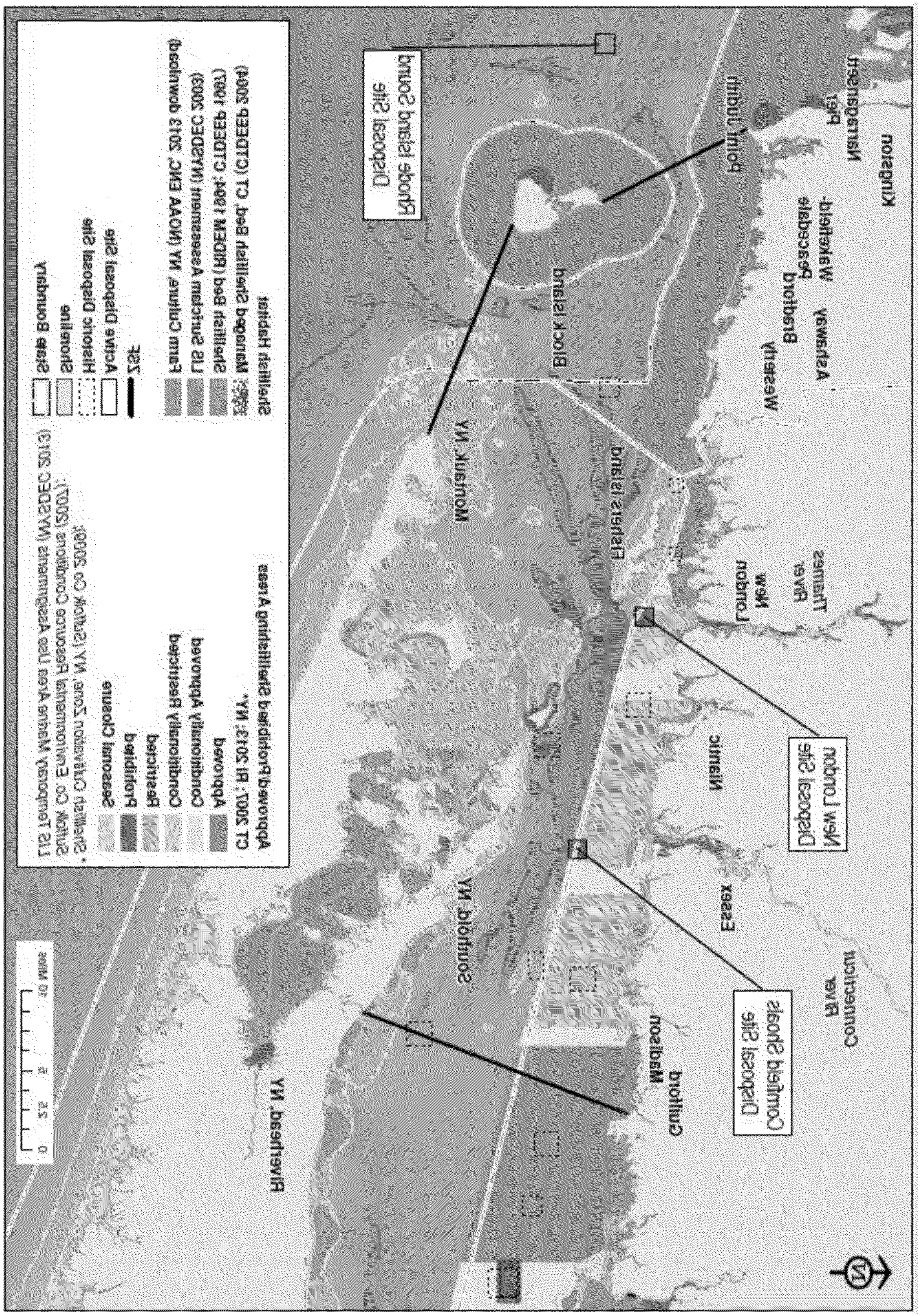


Figure 74. Shellfish zoning in the ZSF (GIS compilation; July 22, 2013).

3.14.2 Commercial Navigation

Data Needs: Data on commercial navigation and shipping, navigation-based activities, as well as information on dredging needs to keep harbors and port facilities operational.

Existing Information: Information on the existing density of commercial vessel traffic is presented in Figure 75.

The Long Island Sound Dredged Material Management Plan Dredging Needs Report (Battelle, 2009) assessed the needs for dredging of harbors and ports. The anticipated volumes of sediment to be dredged between 2007 and 2037 for dredging centers within the ZSF are presented i n Figure 76. In 2001, the USACE conducted a survey of commercial and navigation-dependent facilities, which identified 959 facilities in LIS, 513 in CT and 446 in New York (USACE, 2001). The RIR EIS provides dredging needs information for Rhode Island coastal communities bordering BIS for the 20-year period from 2002 to 2021.

Economic and other information pertaining to ports and harbors is expected to be available from federal and state agencies, municipalities, and other organizations, including CTDOT, Connecticut Maritime Commission, Port Authority of New York and New Jersey, Rhode Island Economic Development Corporation (RIEDC), Rhode Island Marine Trades Association, New London Port Authority, harbor management commissions, municipal port and waterfront authorities, ferry operators, and others.

Potential Other Sources: n/a.

Data Gaps: None expected.

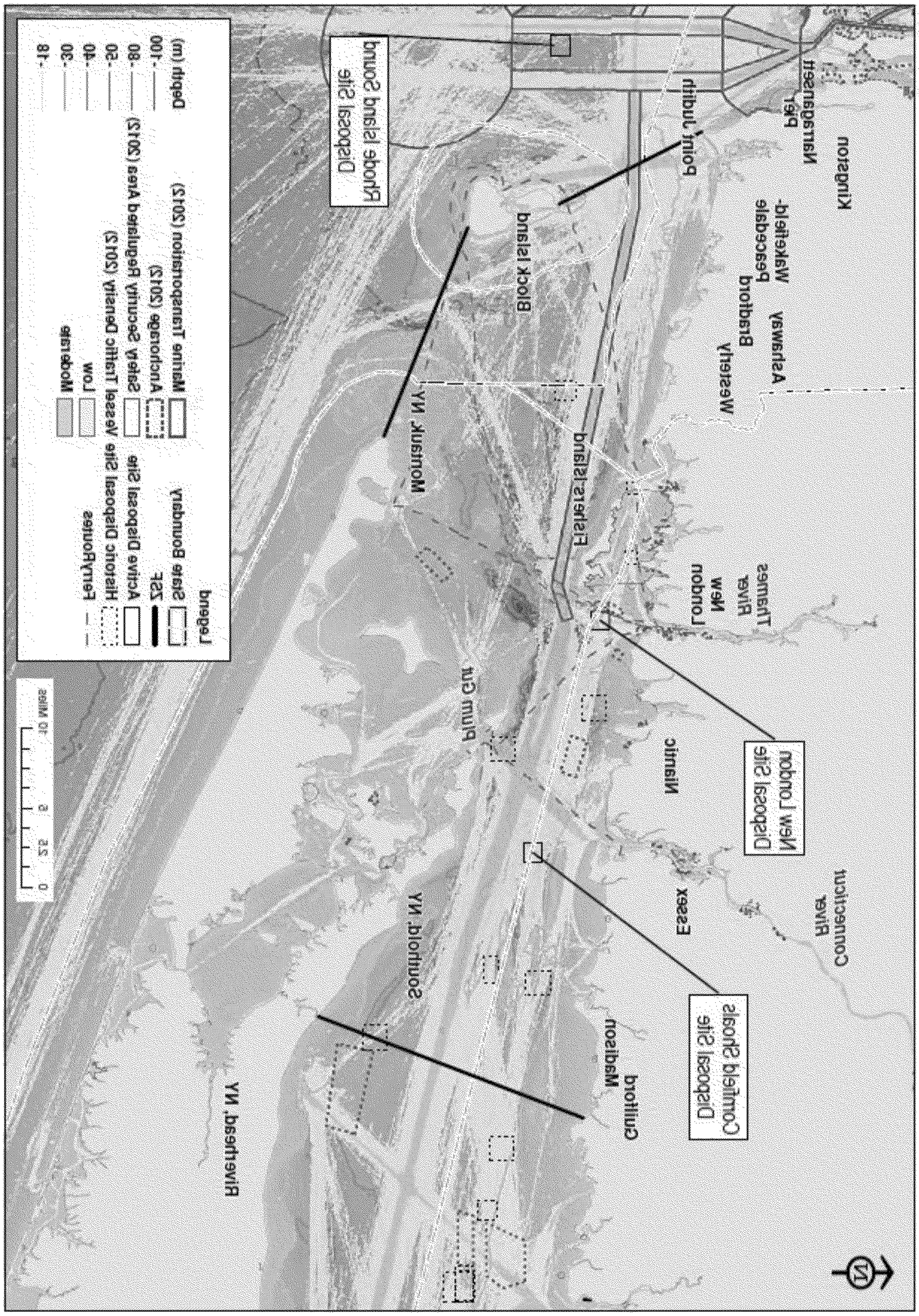


Figure 75. Density of commercial vessel traffic in the ZSF (GIS compilation; June 24, 2013).

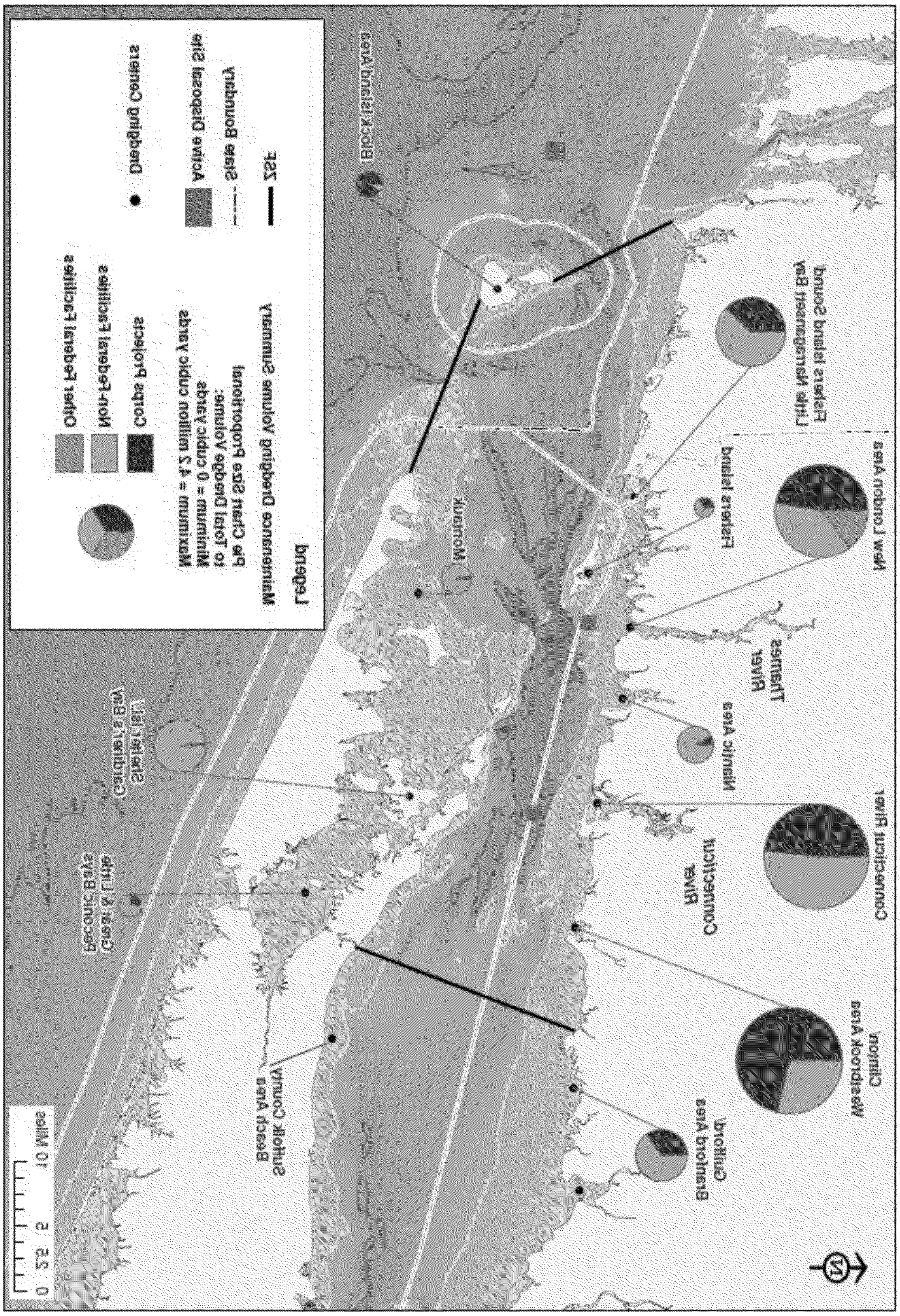


Figure 76. Anticipated volumes of sediment anticipated to be dredged between 2007 and 2037 from individual dredging centers in the ZSF (GIS compilation; June 24, 2013).

3.14.3 Recreational Activities and Beaches

Data Needs: Data about the recreational activities in the waters of the ZSF consisting of boating, swimming, sunbathing, and dining; fishing and shellfishing are discussed in Section 3.14.1.

Existing Information: Recreational v essel traffic d ensity data are available at the Northeast Ocean Data Portal, based on the 2012 Northeast Recreational Boater Survey conducted by SeaPlan and the Northeast Regional Ocean Council (NROC), in partnership with state coastal management programs and state marine trades associations in the Northeast (Figure 77). Details about the economic value of recreational boating are included, for example , in Connelly et al. (2004) and Altobello (1992).

Information about public beaches is available from the DMMP, as well as state agencies and municipalities. As stated in the WLIS/CLIS EIS, based on USACE (1981), diving occurs primarily in sheltered waters of LIS, where waters are clearer.

Additional information about recreational resources is also included in NOAA's Environmental Sensitivity Index maps. The map coverage in the ZSF is shown in Figure 78 ; an excerpt of the map from the mouth of the Thames River is shown in Figure 79 as an example.

Potential Other Sources: n/a.

Data Gaps: None.

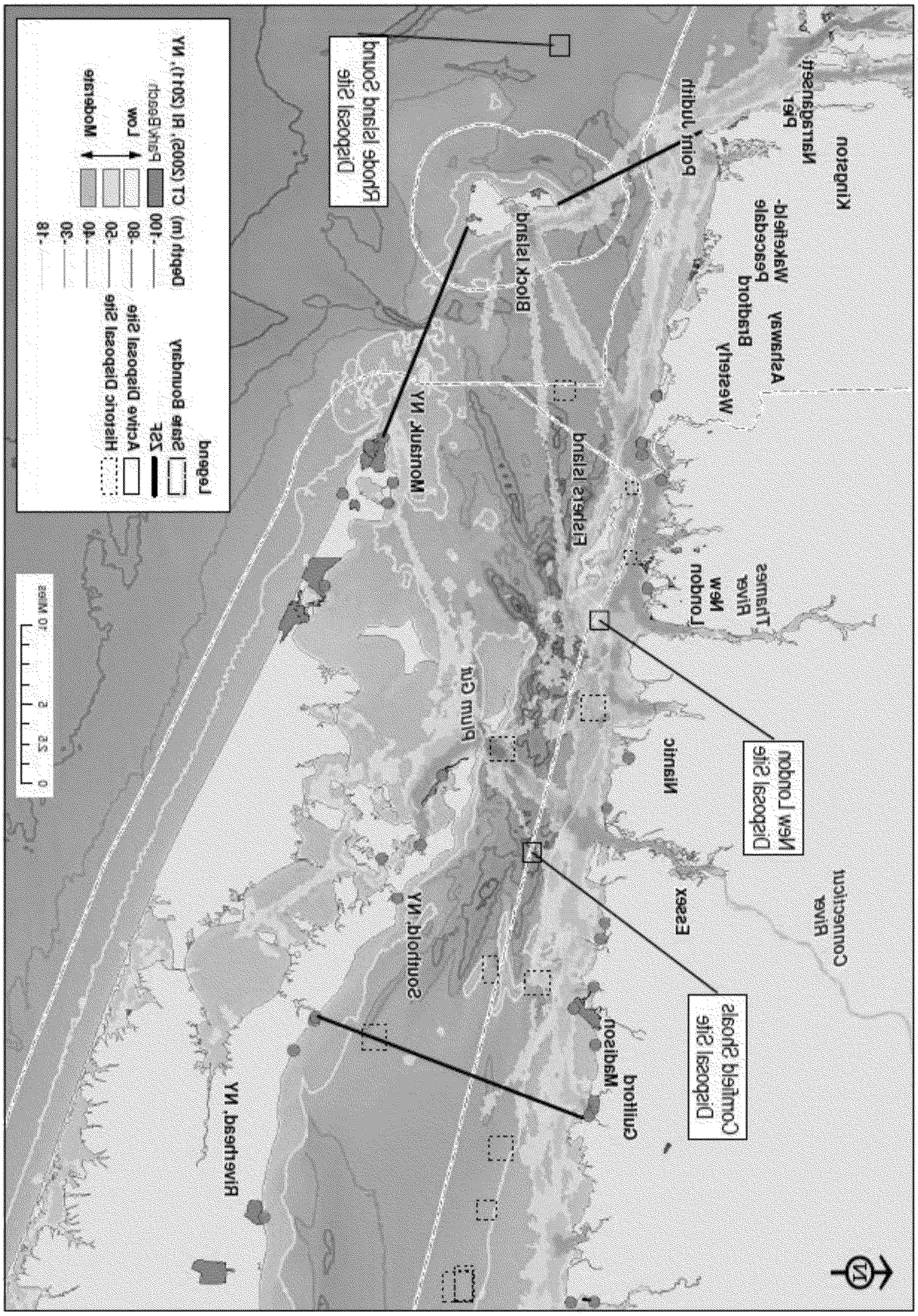


Figure 77. Recreational areas and boating in the ZSF (GIS compilation; June 24, 2013).

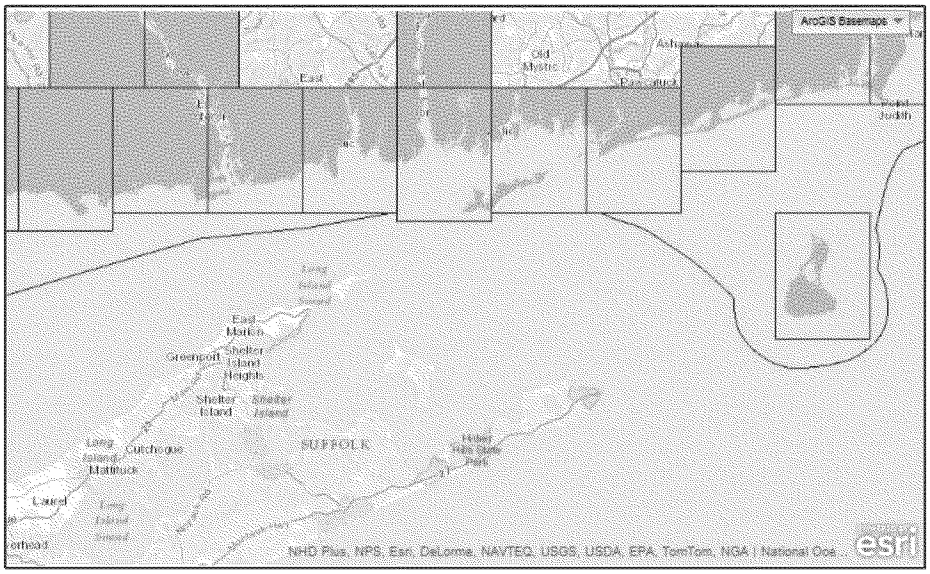


Figure 78. Index map of available Environmental Sensitivity Index maps (NOAA, 2013).

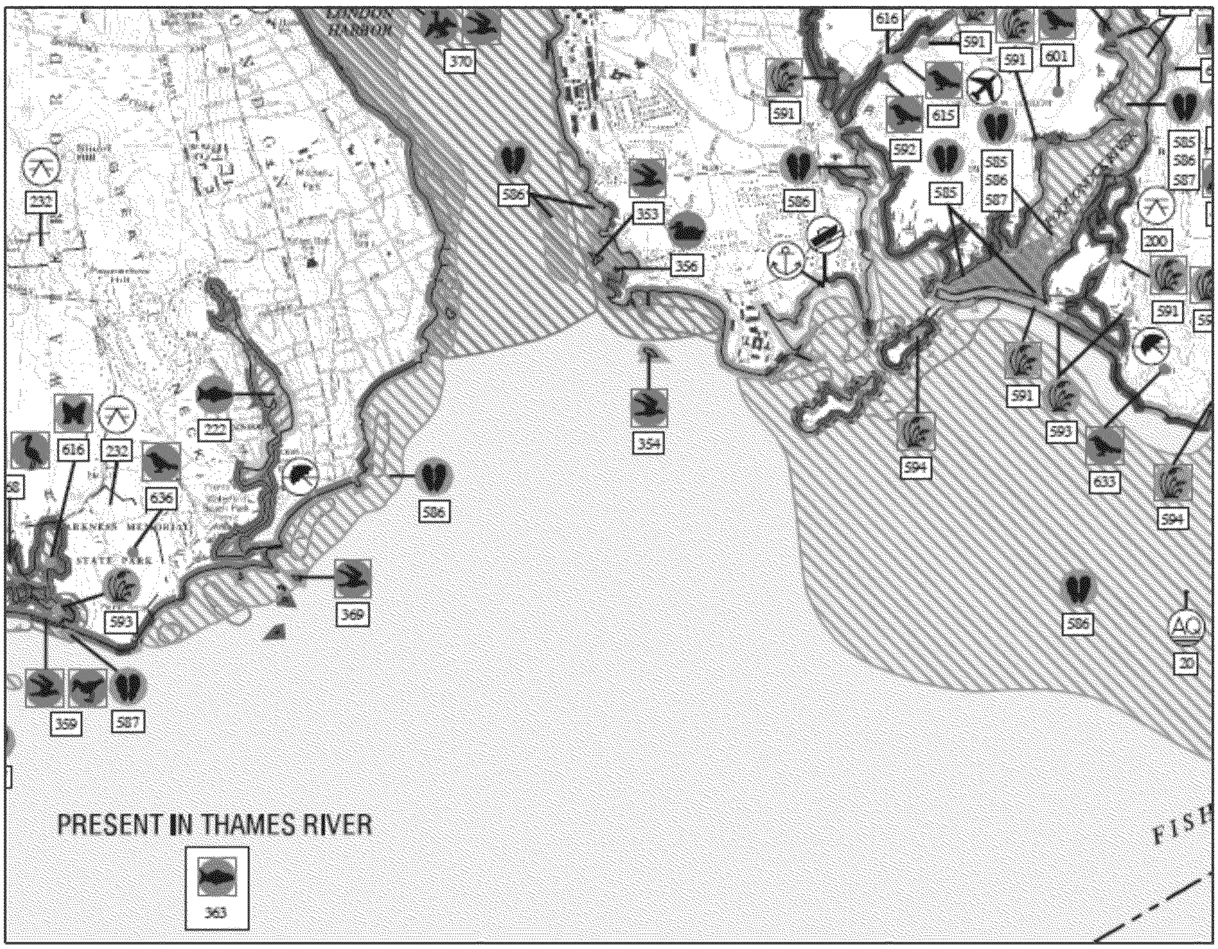


Figure 79. Environmental Sensitivity Index Map from the mouth of the Thames River (NOAA, 2013). (Note: legend available on the web site.)

ED_001437D_00000426-00120

3.14.4 Parks and Natural Areas

Data Needs: Information about parks and natural areas both along the shore as well as offshore.

Existing Information: Available information is available from federal state agencies and other organizations, including municipalities, etc. The available information includes locations of all state-managed parklands, beaches, and sanctuaries in the ELIS area. Available information on conservation areas (including parks and natural areas) in the ZSF is summarized in Figure 80.

Potential Other Sources: n/a.

Data Gaps: None expected.

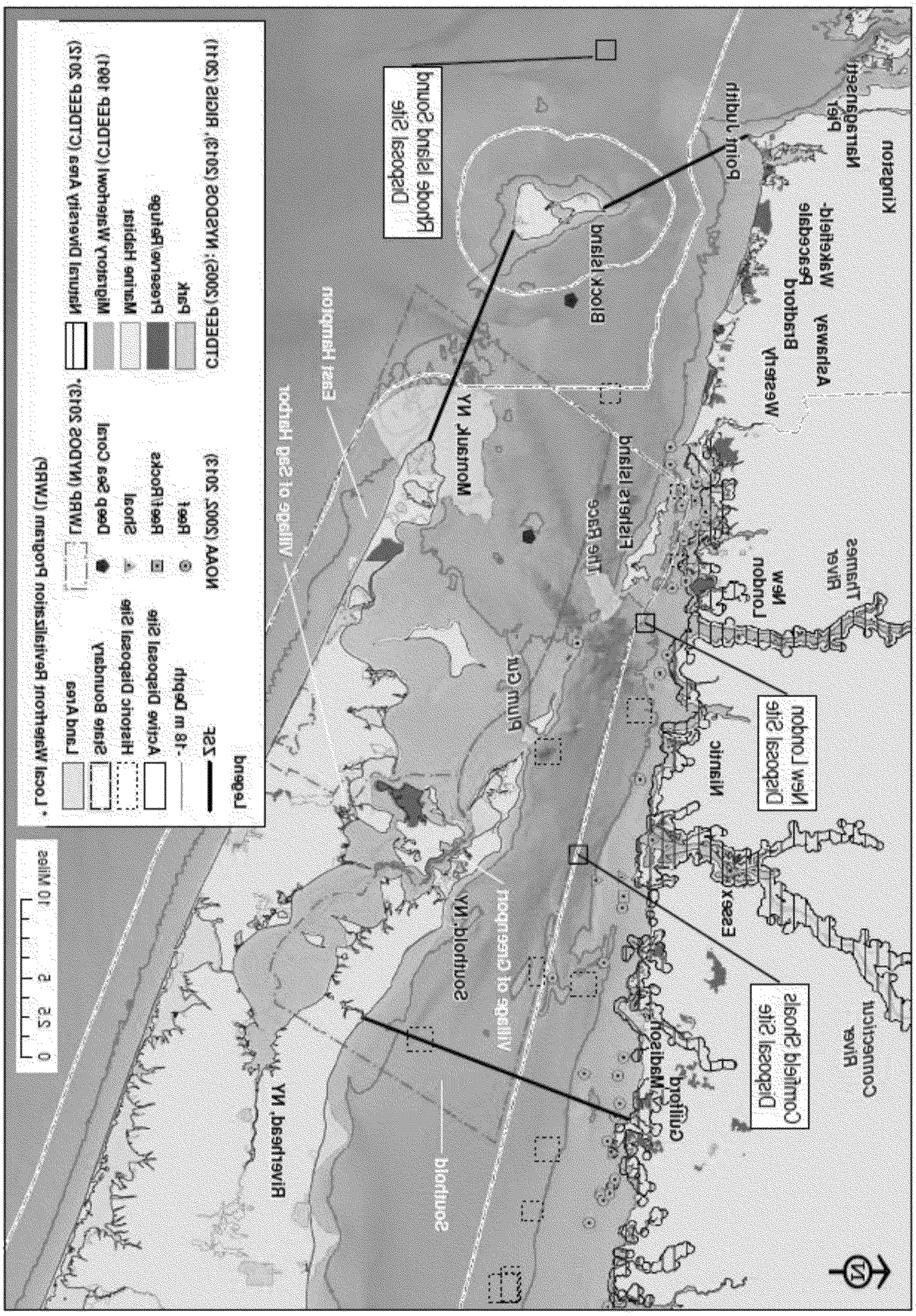


Figure 80. Conservation areas in the ZSF (GIS compilation; June 24, 2013).

3.14.5 Historical and Archaeological Resources

Data Needs: Archaeological information pertaining to shipwrecks and other cultural resources at potential disposal sites.

Existing Informatio n: Available information on shipwrecks and obstructions in the ZSF is summarized in Figure 81 (see Section 2.3 for additional details on the data source).

PAL (2010) prepared a cultural resources inventory for the DMMP that included archaeological sites and sensitivity of the coastal area bordering LIS and BIS. This inventory included an area underwater within one-half mile of the shoreline and inland at a distance of no greater than 10 miles, *i.e.*, not in deeper ZSF waters considered for potential dredged material disposal sites. The literature within WHG (2010) did not provide any documents on archaeological resources.

Potential Other Sources: Additional archaeological and cultural resources information might be available from the USACE for the two active disposal sites.

Data Gaps: The NOAA database is considered adequate for screening within the ZSF; however, a more in-depth assessment for potential cultural, historic, and archaeological resources of shipwrecks at alternative disposal sites is needed. Additional steps include a review of state archaeological site file inventories in Connecticut, New York and Rhode Island ; and coordination with SHPOs and Native American Tribes. The findings of the file review and coordination would determine if marine archaeological surveys are needed at potential alternative disposal sites.

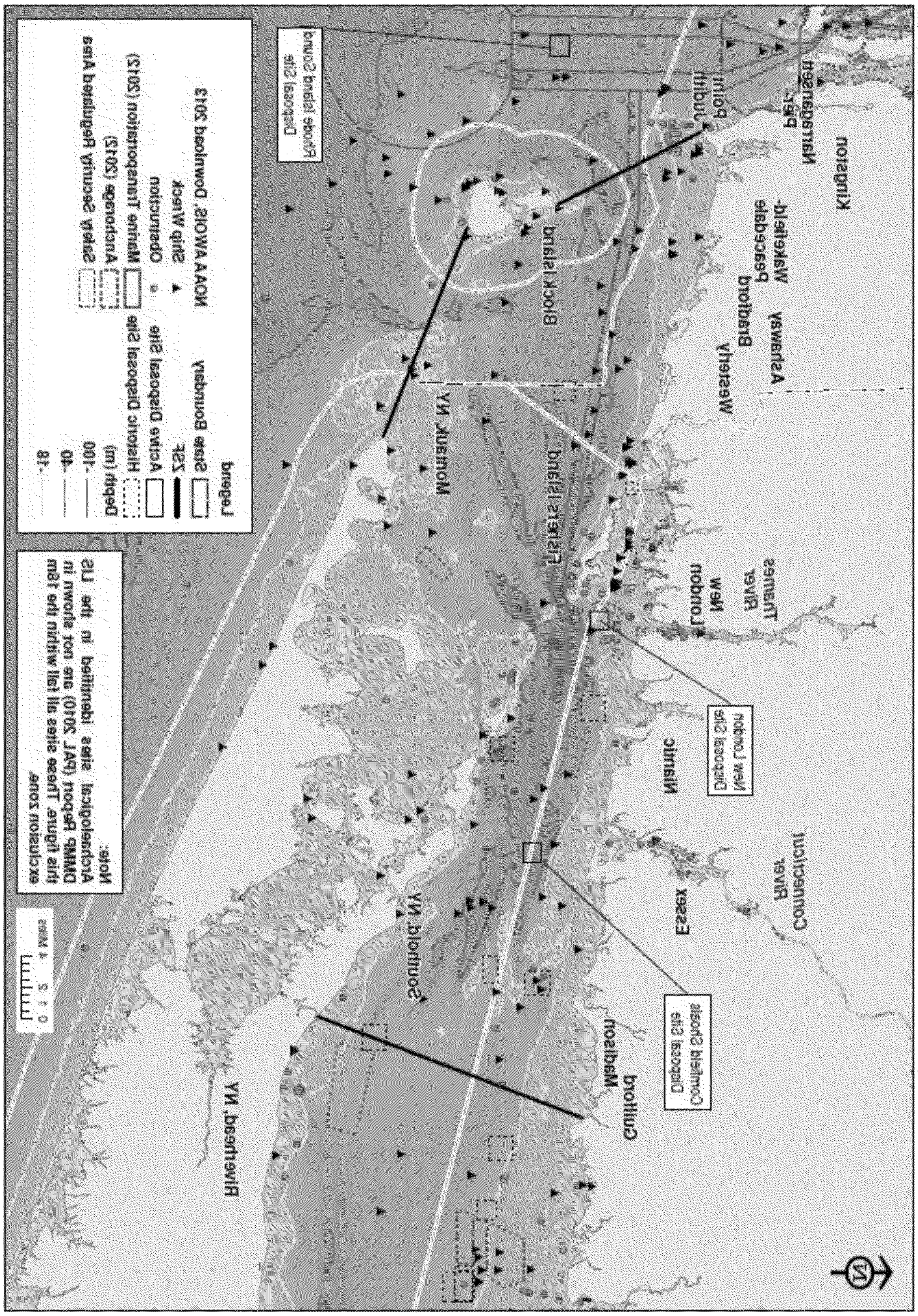


Figure 81. Shipwrecks and obstructions in the ZSF (GIS compilation; June 23, 2013).

3.14.6 Active and Historic Disposal Activities and Disposal Sites

Data Needs: Data and information regarding active and historic disposal site usage, including geographic location, years of usage, types of sediment deposited, monitoring performed, and reports. MPRSA gives preferences to active and historic sites over new sites for alternative disposal site selection.

Existing Information: Records of disposal activities at the active and historic disposal sites are kept by the USACE (Figure 82). As stated previously, the two active sites are regularly monitored though the USACE's DAMOS program. The USACE has information pertaining to individual active and historic sites.

The RIR EIS did not describe the historic Block Island Sound Disposal Site, even though it was within its ZSF.

Potential Other Sources: n/a

Data Gaps: It is anticipated that the available information will confirm the historical use of these sites (except perhaps for the Block Island Sound Disposal Site). It is expected that the USACE's information will allow for characterization of historic disposal activities at these sites and provide information on their position (latitude and longitude).

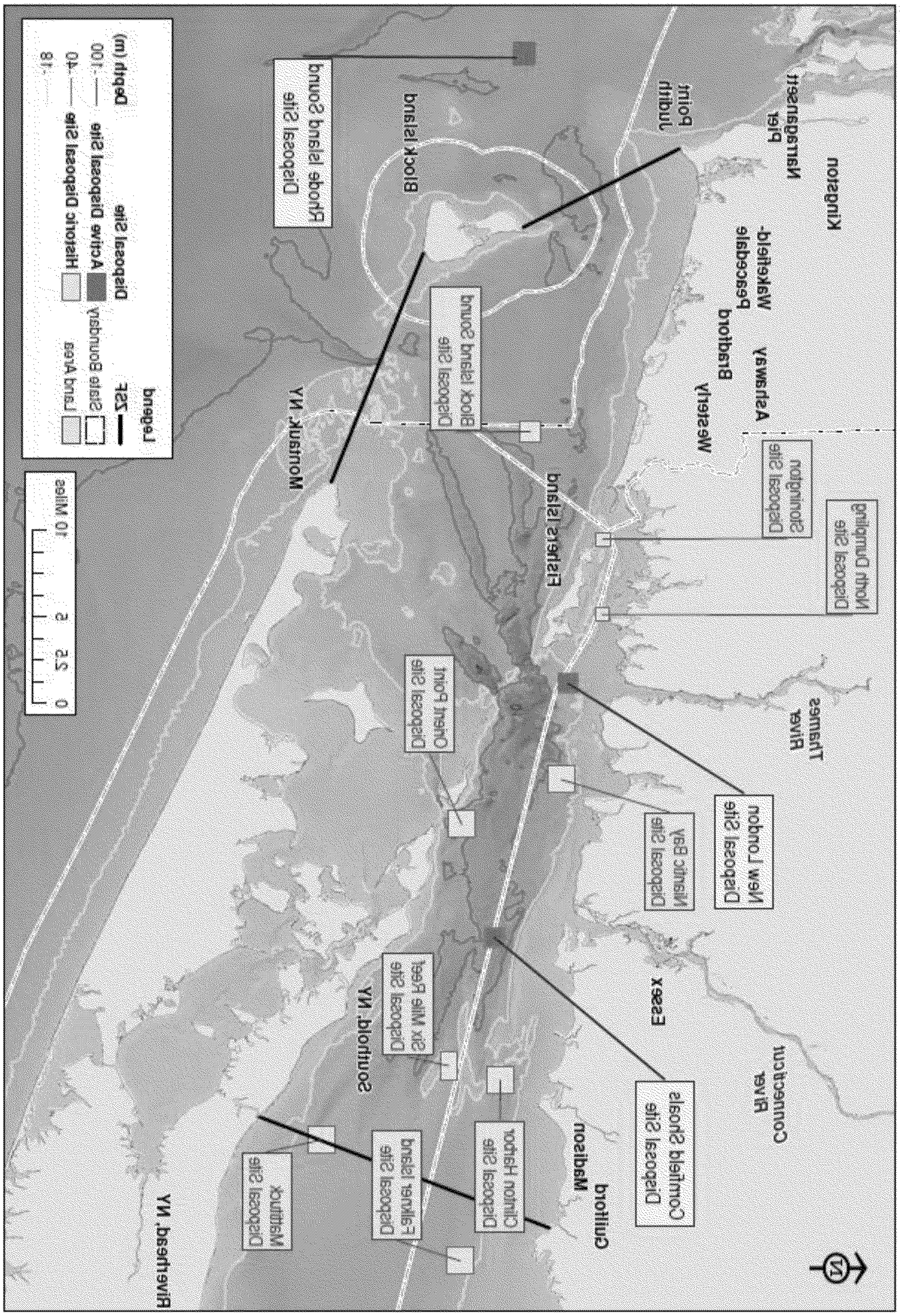


Figure 82. Active and historic disposal sites in the ZSF (GIS compilation; June 28, 2013).

3.14.7 Other Human Uses

Data Needs: Other human uses including military use [(MPRSA 228.6(a)(8)], mineral and energy development [(MPRSA 228.6(a)(8), 228.6(a)(3)], and renewable ene rgy development potential.

Existing Information: Information on military sites is expected to be readily available from sources such as the U.S. Navy, NOAA, and port organizations. This includes navigation corridors, anchorage areas, and other relevant facilities (included in Figure 75).

Existing cables for power and communication needs and pipelines in the ZSF are presented in Figure 83. Pipelines are limited to a few locations near the coast.

Other human uses include renewable energy (wind, wave, tidal). Sufficient information is available from the Department of Energy to assess the renewable energy potential within the ZSF (Figures 84 to 86).

Potential Other Sources: n/a.

Data Gaps: Some additional information will need to be obtained for cable corridors to determine if cables were installed within these corridors, and if so, if those cables are active.

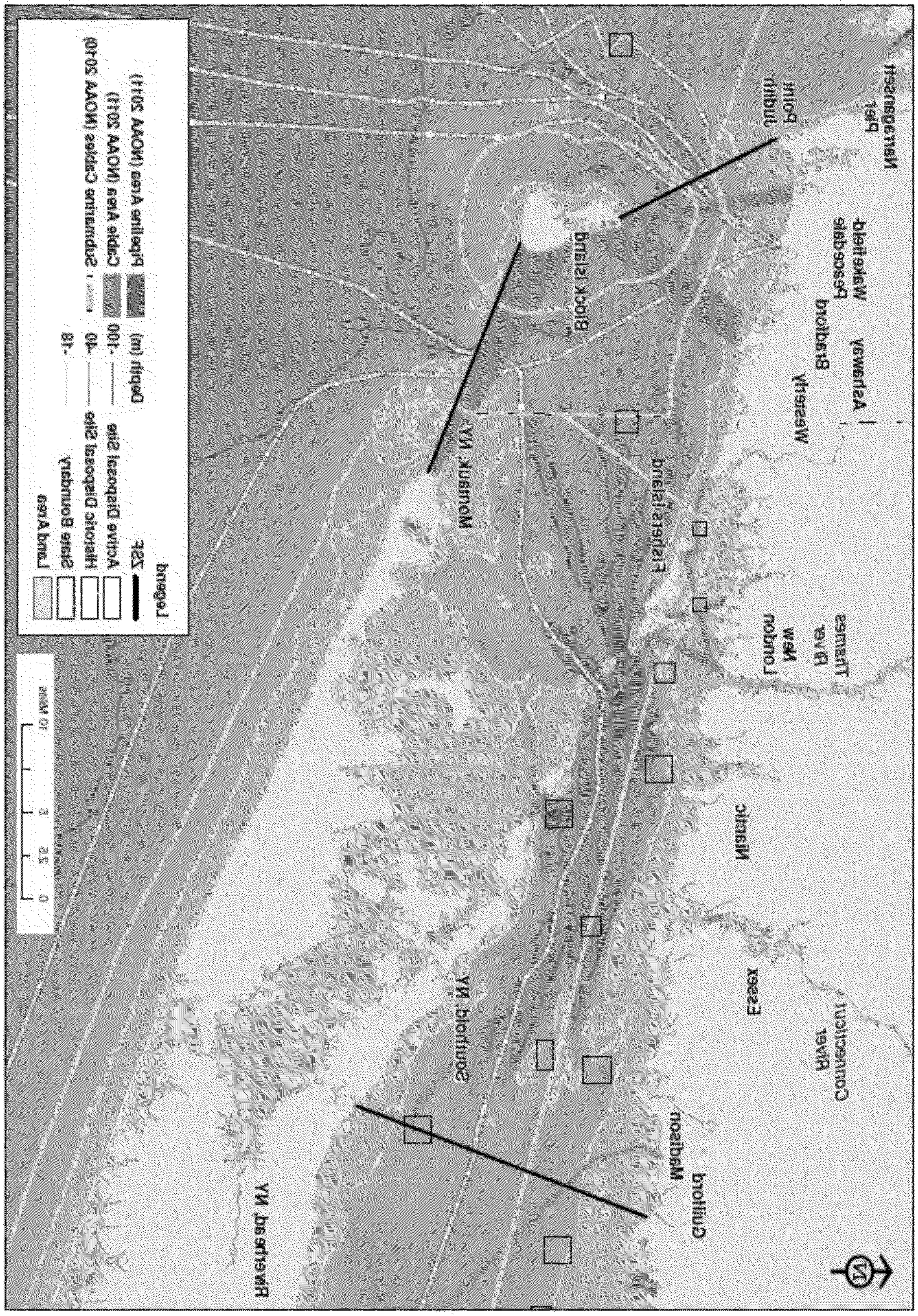


Figure 83. Cable and pipeline areas in the ZSF (GIS compilation; June 24, 2013).

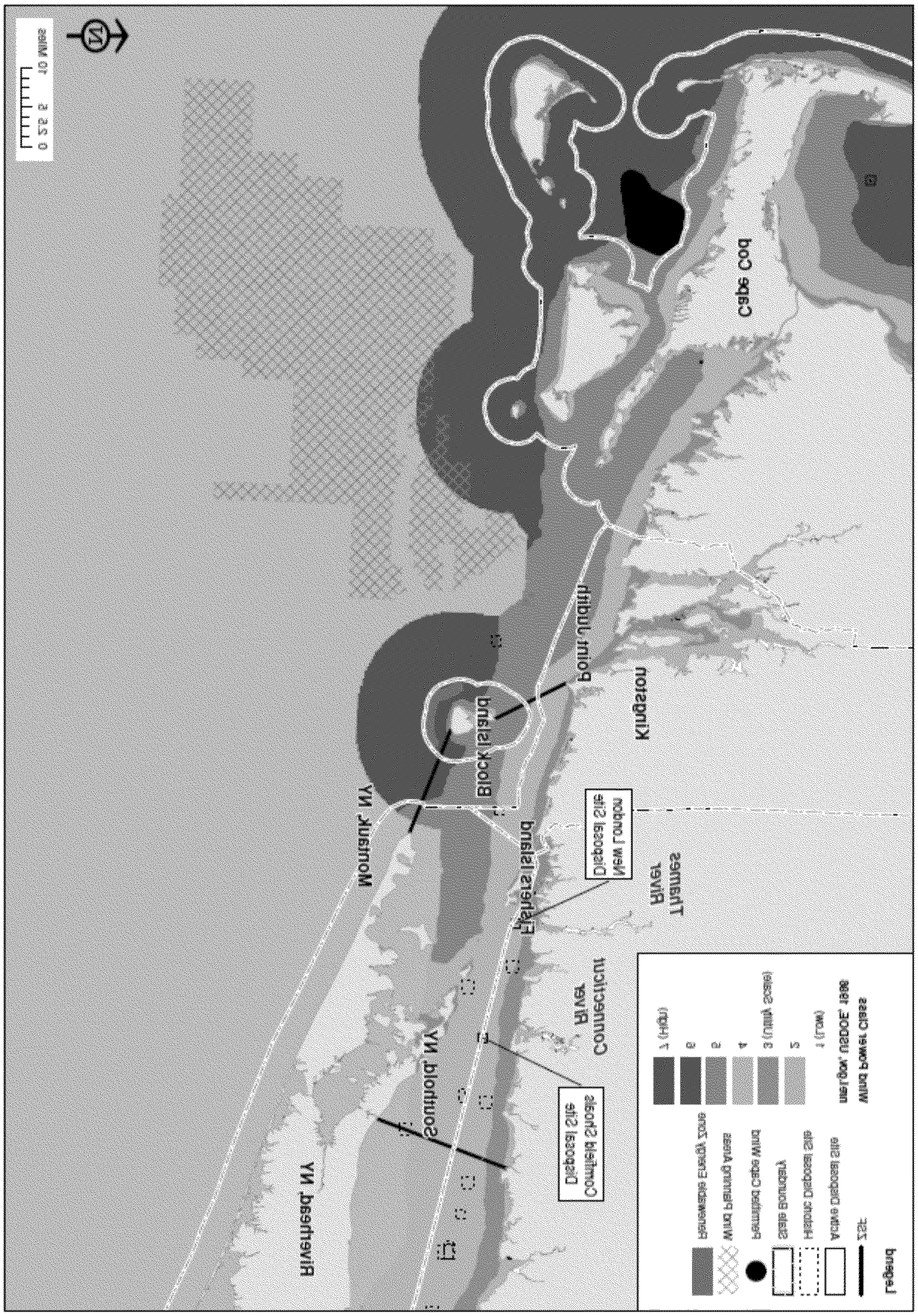


Figure 84. Wind energy potential in the ZSF (GIS compilation; May 19, 2013)

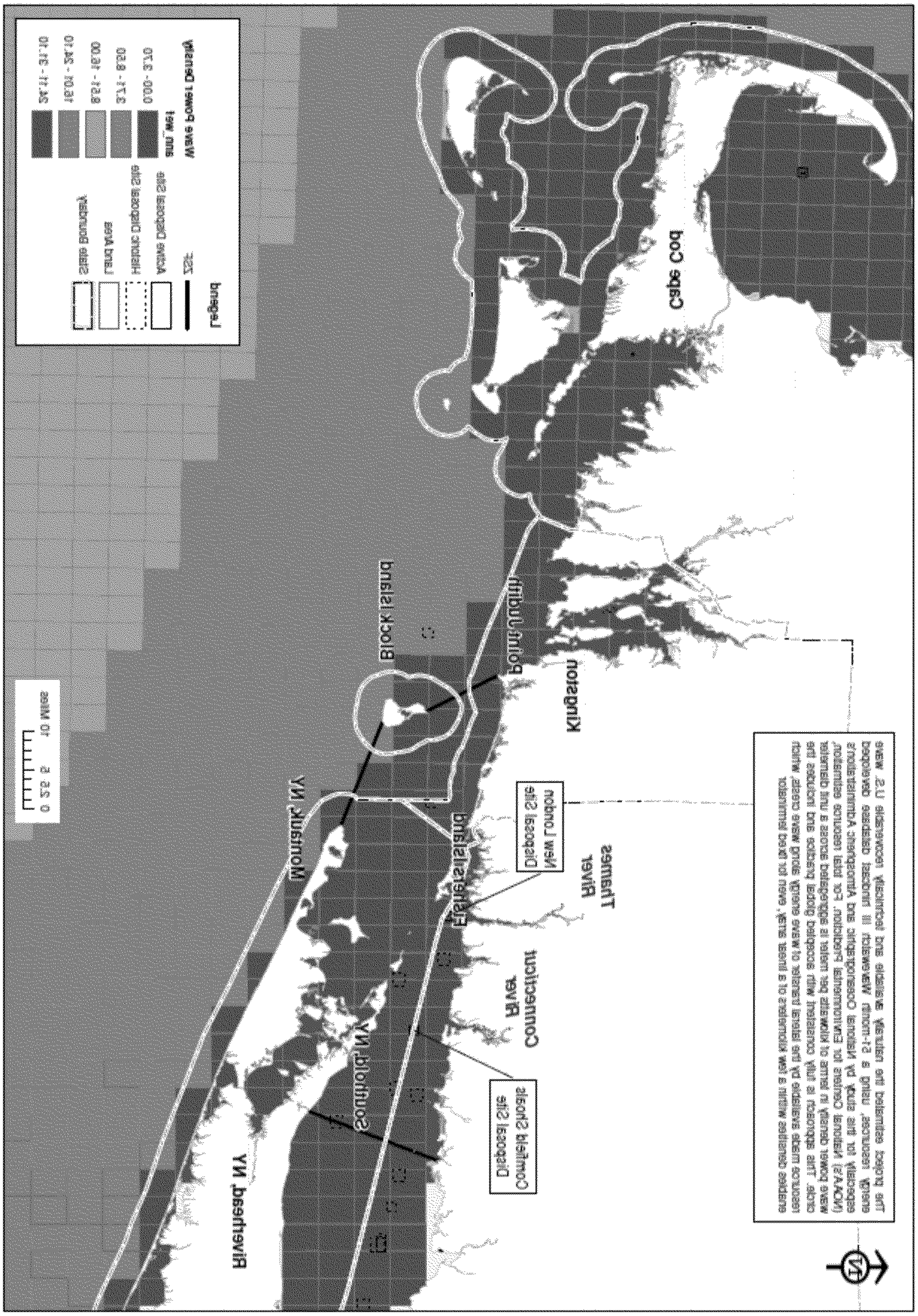


Figure 85. Wave energy potential in the ZSF, expressed as wave power density (GIS compilation; May 19, 2013)

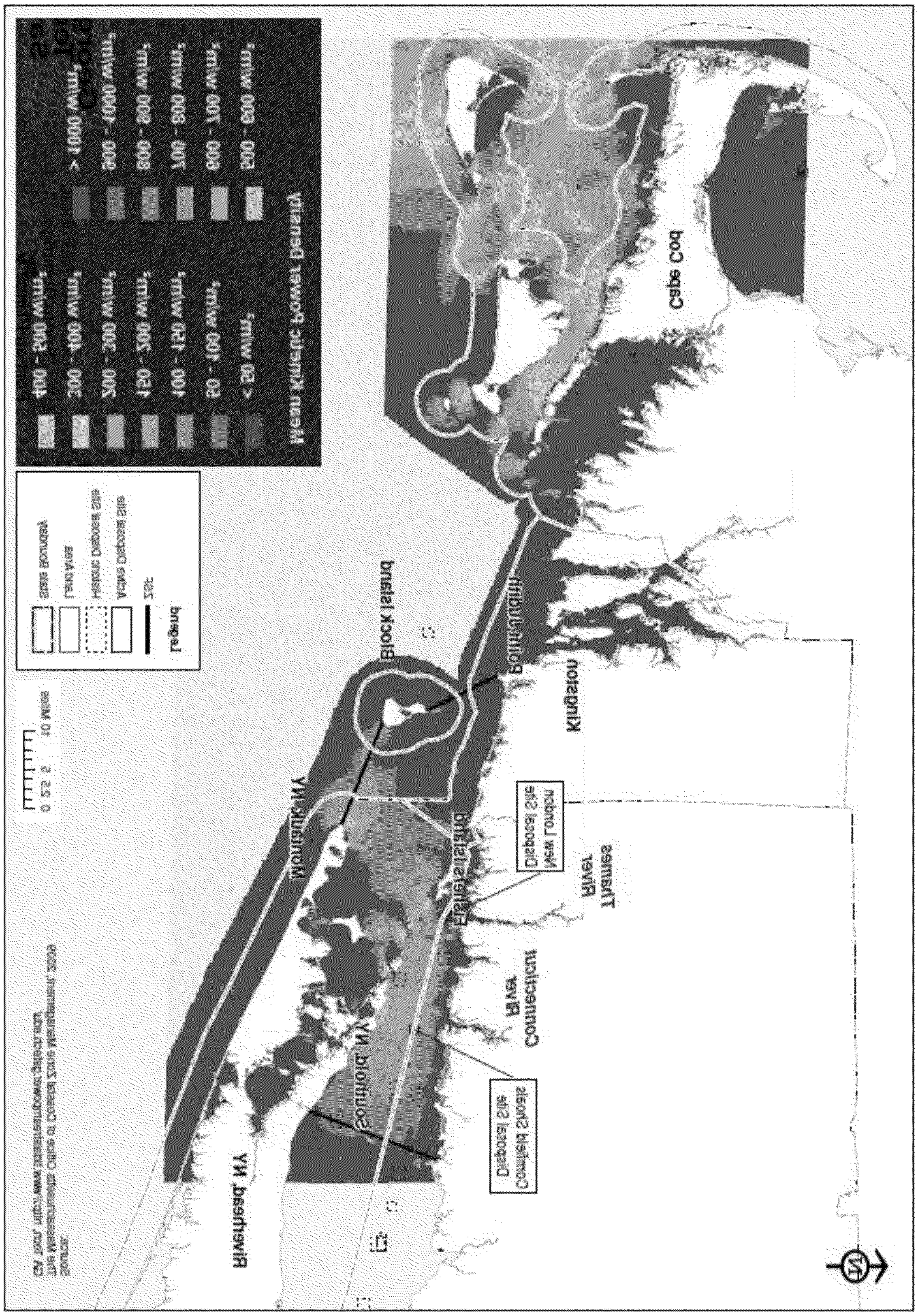


Figure 86. Tidal energy potential in the ZSF, expressed as mean kinetic power density (GIS compilation; May 19, 2013)

3.15 Air Quality and Noise

Data Needs: Background air quality and noise conditions to assess potential impacts from dredged material disposal operations.

Existing Information: The CLIS/WLIS EIS cites data from the CTDEEP (air quality) and USEPA (ozone). Background noise levels vary depending on disposal location, but are expected to be very low at disposal locations. The noise at the offshor e alternative disposal sites includes sounds generated by a variety of large commercial and recreational vessels, including ferries, as well as natural sources natural considered normal background noise. General air quality and noise information data for LIS are also available in the Broadwater LNG EIS (FERC, 2008).

Potential Other Sources: n/a

Data Gaps: None expected. A ir quality and noise impacts can be modeled, if needed, depending on the selected alternative disposal sites.

4.0 SUMMARY AND NEXT STEPS

4.1 Existing Data

Data and information that are readily available and identified in this literature search, as well as additional data and information that are expected to be available from state and federal agencies, universities, and other organizations, will be used for a general characterization of the ELIS and BIS for the resource issues.

Data are also considered for initial screening of potential disposal sites in the ZSF. However, additional data may need to be obtained and analyzed.

4.2 Primary Resource Considerations for Site Screening

As stated in Section 2.1, MPRSA provides criteria to be considered for the screening of dredged material disposal sites (Table 2). Based on review of existing information for the ELIS, the following resources, issues, and factors are considered to be the most relevant decision criteria for the selection of disposal sites within the ZSF (the corresponding MPRSA criteria are included below in square brackets):

- **Water depth** [228.5(b); 228.6 (a)(1)]: Generally, greater water depths are found further away from sensitive coastal and nearshore resources, and sediments at greater depths are less susceptible to wave-driven resuspension.

- **Physical oceanography** [228.5(b)]: Currents and waves determine the transport of sediment during disposal, as well as redistribution of deposited sediment following resuspension during storm events. Preliminary model results are available that identify areas of elevated bottom stress in the ZSF.

- **Benthic habitat (sediment texture and seafloor morphology)** [228.6(a)(1,2)]: Generally, sediment texture (*e.g.*, clay/silt, sand, gravel, boulders) and seafloor morphology (*e.g.*, rock outcrops, sand waves, mud flats) affect the suitability of the habitat for benthic organisms (including lobsters, crabs, oysters, worms, etc.). Specifically, sediment texture and morphology affect breeding, spawning, nursery, feeding, and shelter of species at various life stages. As reflected by grain size data and multibeam bathymetric information, benthic habitats vary considerably in the ZSF.

- **Shellfish resources, zoning, and commercial and recreational harvesting** [228.5(a); 228.6(a)(8)]: Shellfish resources include oysters, clams, scallops, and lobsters. Shellfish zoning is generally based on the abundance of attached shellfish (oysters) and shellfish with limited mobility (clams, scallops). There is considerable annual variability that needs to be considered, such as the decline in lobster abundance over the last 15 years.
- **Finfish resources, and commercial and recreational fishing** [228.5(a); 228.6(a)(8)]: Generally, fisheries data indicate that fishing occurs throughout the ZSF, although unusual

seafloor morphology may result in localized special conditions, such as at the deep holes north of Orient Point and south of Fishers Island.

- **Navigation and infrastructure** [228.5(a); 228.6(a)(8)]: There is active commercial vessel traffic, which includes ferry operations. Identified infrastructure in the ZSF consists of submarine cables. In addition, there are five anchorage areas in the ZSF.

- **Conservation areas** [228.5(b); 228.6 (a)(3)]: Beaches, parks, nature preserves, etc. are located along the shore and in nearshore areas throughout the ZSF. There are no designated protected areas in deeper waters of the ZSF (*e.g.*, in waters deeper than 18 m).

- **Archaeological resources** [228.6(a)(11)]: Shipwrecks are scattered throughout the ZSF.

- **Active and historic disposal sites** [228.5(e)]: There are two active disposal sites and seven historic sites in the ZSF.

- **Interference with other uses [** 228.6(a)(8)]: Information is available about future dredging needs by the communities surrounding the ZSF harbors and coastal facilities, and about potential socio economic impacts under the no-action alternative and for comparisons between potential alternative disposal sites.

4.3 Initial Site Screening

Based on primary resource considerations following MPRSA, initial screening has identified 1 1 sites for further consideration. These sites include the two active sites, five areas that had dredged material disposal historically, and four 'new' areas not previously used for disposal.

1. Cornfield Shoals Disposal Site (active)
2. Six Mile Reef Disposal Site (historic)
3. Clinton Harbor Disposal Site (historic)
4. Orient Point Disposal Site (historic)
5. Niantic Bay Disposal Site (historic)
6. New London Disposal Site (active)
7. Deep Hole south of Fishers Island – West (new)
8. Deep Hole south of Fishers Island – East (new)
9. Deep Hole south of Fishers Island – Central (new)
10. Block Island Sound Disposal Site (historic)
11. Area north of Montauk (new)

4.4 Next Steps

Additional data and information will need to be obtained and reviewed include the following:

- **Physical oceanography study:** The data gap assessment for physical o ceanographic information revealed an absence of bottom stress information (Appendix C). The variations in the bottom stress are controlled largely by the vertical structure of currents driven by tides, wind, and waves. To estimate the stress distributions in the ZSF, these processes have to be simulated correctly within the model. Bottom stress, current profiles, and wave field characteristics need to be measured during a range of meteorological and river discharge conditions expected within the ZSF. Measurements should be made in the spring when river flow is high, in the early summer when the wind stress is weak, and in the winter when the wind stress is high.

Based on the collected field data, as well as existing data, the sediment resuspension potential during extreme events (*i.e.,* storms) should be modeled and the path of resuspended sediment should be determined. Similarly, the path of suspended sediment during dredged material disposal operations should be modeled.

- **Field studies and surveys:** Aside from physical oceanographic data, more detailed data and information for NEPA analysis for environmental resources at individual potential alternative disposal sites are needed, such as for the following resources:
  - *Benthic organisms and sediment geochemistry:* Sediment chemistry includes metals, organic compounds, total organic carbon and toxicity. Benthic habitat information is to be obtained through Sediment Profile Imaging (SPI) camera and/or benthic grab samples.
  - *Substrate and benthic habitat:* Additional substrate (sediment texture, seafloor morphology) and habitat information for two potential alternative disposal sites for which multibeam bathymetric data are not available, *i.e.*, the area north of Montauk, and the northern part of the Clinton Harbor Disposal Site.
  - *Commercial and recreational fishing:* Information on lobster and recreational fishing by conducting targeted surveys of fishermen and/or inquiring at resource agencies (CTDEEP, NYSDEC, RIDFW, NMFS).
  - *Contaminant levels in fish and shellfish:* Could be considered after further analysis of chemical data collected in the summer.

- **Other steps:** Existing data need to be analyzed and reviewed to obtain a better understanding of conditions at initially screened sites. Key desktop assessments include, but are not limited to the following:
  - *Benthic habitat:* Review of relevant videos and photographs of the benthic habitat available at UCONN (Ivar Babb) and the USGS in Woods Hole (Larry Poppe).
  - *Fisheries data for finfish and shellfish:* Review of CTDEEP trawl survey data for individual species. Similar, review and analysis of available fisheries data from RIDFW and NMFS for BIS.
  - *Infrastructure:* Determination if cables within designated cable corridors actually exist within these corridors and, if so, are active or abandoned. Similarly, determination if designated anchorage areas in the ZSF are still in active use.

- *Archaeological resources:* Consultation with Native American Tribes and SHPOs for relevant for potential alternative disposal sites. Determination if selected field surveys are needed.

5.0 REFERENCES

AECOM. 2011. Monitoring Survey at the Seawolf Disposal Mound, June/ July 2006. DAMOS Contribution No. 183. U.S. Army Corps of Engineers, New England District, Concord, MA, 92p.

AECOM. 2012. Monitoring Survey at the Seawolf Disposal Mound, September 2010. DAMOS Contribution No. 189. U.S. Army Corps of Engineers, New England District, Concord, MA, 136p.

Altobello, M. A. 1992. The economic importance of Long Island Sound's water quality dependent activities. University of Connecticut, Storrs, CT.

Aurin, D.A. and H.M. Dierssen. 2012. Advantages and limitations of ocean color remote sensing in CDOM-dominated, mineral-rich coastal and estuarine waters. *Remote Sensing of Environment,* v. 125, p. 181–197.

Auster, P.J. and R.E. DeGoursey, 2000. Megafaunal Interactions with Sedimentary and Biological Habitats in the Southern New England Sounds Region: A Pictorial Overview. In: Paskevich, V.F. and L.J. Poppe (eds.), Georeferenced Sea-Floor Mapping and Bottom Photography in Long Island Sound, USGS Open File Report 00-304, Chapter 11. Available at: http://pubs.usgs.gov/of/of00-304/htmldocs/chap11/index.htm

Battelle. 2009. Long Island Sound Dredged Material Management Plan Dredging Needs Report. Final Report. Submitted to the U.S. Army Corps of Engineers, North Atlantic Division, Contract No. DACW33-03-D-0004, Delivery Order No. 43 (October 2009).

Battelle. 2013. Task 2 Report, Literature Search /Data Gaps (Draft). Submitted to Connecticut Department of Transportation (February 14, 2013).

Balcom, N. and P. Howell. 2006. Resource Disaster: American Lobsters in Long Island Sound 1999 – 2004. Connecticut Sea Grant, CTSG-06-02.

Barshaw, D.E. and D.R. Bryant-Rich. 1988. A long-term study on the behavior and survival of early juvenile American lobster, *Homarus Americanus,* in three naturalistic substrates: eelgrass, mud, and rocks. *Fishery Bulletin,* v. 86, p. 789-796.

Battista, T. and K. O'Brien. 2012. What lies beneath. *Geospatial World*, v. 3, p. 36-38.

Buchholtz ten Brink, M.R., E.L. Mecray, E.L. Galvin, K. Feldman. 2000. *Clostridium perfringens* distribution in Long Island Sound sediments: Data report. In: Paskevich, V.F. and L.J. Poppe (eds.), Georeferenced Sea-Floor Mapping and Bottom Photography in Long Island Sound, *USGS Open-File Report 00-304,* Chapter 8. Available at: http://pubs.usgs.gov/of/of00-304/htmldocs/chap08/index.htm

ED_001437D_00000426-00137

CASE (The Connecticut Academy of Science and Engineering). 2004. Long Island Sound Symposium: A Study of Benthic Habitats. Prepared for the Connecticut Energy Advisory Board. (November 2004).

Chapman, P.M. 2000. The sediment quality triad: then, now and tomorrow. *International Journal of Environment and Pollution,* v. 13, p. 351-356.

Connelly, N.A., T.L. Brown, and D.L. Kay. 2004. Recreational Boating Expenditures in New York State and Their Economic Impacts. Prepared for New York Sea Grant.

CTCEQ (Connecticut Council on Environmental Quality). 2007. Environmental Quality in Connecticut – Council on Environmental Quality 2006 Annual Report. Available at: http://www.ct.gov/ceq/lib/ceq/ceq2006_report_(2).pdf.

CTDEEP (Connecticut Department of Energy and Environmental Protection). 2005. Monitoring phytoplankton community composition in Long Island Sound with HPLC photopigment profiles. Fact Sheet. Available at: http://www.ct.gov/deep/lib/deep/water/lis_water_quality/hypoxia/phytoplanktonfactsheet.pdf

CTDEEP (____). 2010 . Connecticut's endangered, threatened and special concern species. CTDEEP Bureau of Natural Resources. Available at: http://www.ct.gov/deep/lib/deep/wildlife/pdf_files/nongame/ets10.pdf

CTDEEP (____). 2012a. A Study of Marine Recreational Fisheries in Connecticut. Prepared by: Prepared by MacLeod, R.E., K.F. Gottschall, D.J. Pacileo, D.R. Molnar, J.M. Benway, M.J. Lyman, and K. O'Brien -Clayton. Federal Aid in Sport Fish Restoration F-54 -R-31 Annual Performance Report , March 1, 2011 to February 29, 2012.

CTDEEP (____). 2012b. DEEP to Study Decline of Lobsters in Long Island Sound. (July 10, 2012). Accessed on July 15, 2013: http://www.ct.gov/deep/cwp/view.asp?A=4173&Q=507752

CTDEEP (____), 2013a. Long Island Sound Water Quality Monitoring. Accessed on July 18, 2013: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325534&deepNav_GID=1654

CTDEEP (____). 2013b. DEEP to Study Decline of Lobsters in Long Island Sound. Accessed on July 19, 2013: http://www.ct.gov/deep/cwp/view.asp?A=4173&Q=507752

CTDOT (Connecticut Department of Transportation). 2006. State of Connecticut Maritime Policy. Available at: http://www.ct.gov/dot/cwp/view.asp?a=2314&Q=309828

CTDPH (Connecticut Department of Public Health). 2013. If I Catch It, Can I Eat It? A Guide to Eating Fish Safely 2013 Connecticut Fish Consumption Advisory. Accessed on July 22, 2013 at: http://www.ct.gov/dph/lib/dph/environmental_health/eoha/pdf/ificatchit_2012_english.pdf

Dam, H.G., J. O'Donnell, and A.N.S. Siuda. 2010. A Synthesis of Water Quality and Planktonic Resource Monitoring Data for Long Island Sound. Final Report USEPA Grant Number: LI-97127501

ENSR. 2005. Monitoring Survey at the Cornfield Shoals Disposal Site, June 2004. DAMOS Contribution No. 160. U.S. Army Corps of Engineers, New England District, Concord, MA, 26p.

Fenster, M.S. 1995. The Origin and Evolution of the Sand Sheet Facies: Eastern Long Island Sound. Ph.D. Dissertation, Boston University, 656p.

Fenster, M.S., D.M. Fitzgerald, W.F. Bohlen, R.S. Lewis, C.T. Baldwin. 1990. Stability of giant sand waves in eastern Long Island Sound. Marine Geology, v. 91, p. 207-225.

Fenster, M.S., D.M. Fitzgerald, and M.S. Moore. 2006. Assessing decadal-scale changes to a giant sand wave field in eastern Long Island Sound. Geology, v. 34, p. 89–92.

FERC (Federal Energy Regulatory Commission). 2008. *Final Environmental Impact Statement. Broadwater LNG Project*. Broadwater Energy LLC and Broadwater Pipeline LLC Docket Nos. PF-05-4, CP06-54-000, and CP06-55-000 FERC/EIS – 0196F (January 2008).

Flood, R., R. Cerrato, S. Goodbred, N. Maher, M. Arlotta, and L. Zaleski. 2003. Benthic Habitat Mapping in the Peconic Bays. Stony Brook University, Marine Sciences Research Center, Stony Brook, NY. Available at: http://dspace.sunyconnect.suny.edu/bitstream/handle/1951/51007/Flood.pdf?sequence=1

Goebel, N.L., Kremer, J.N. and C.A. Edwards. 2006. Primary Production In Long Island Sound. *Estuaries and Coasts,* v. 29, p.232-245.

Gottschall, K.F., M.W. Johnson, and D.G. Simpson. 2000. The Distribution and Size Composition of Finfish, American Lobster, and Long-Finned Squid in Long Island Sound Based on the Connecticut Fisheries Division Bottom Trawl Survey, 1984-1994. U.S. Dept. of Comm., *NOAA Tech. Rep. NMFS 148,* 195 p.

Gottschall, K. F. et al. 2006. Marine Finfish Survey. In A Study of Marine Recreational Fisheries in Connecticut, CTDEEP, Bureau of Natural Resources, Marine Fisheries Division. Federal Aid in Sport Fish Restoration. (F-54 -R-25 Annual Performance Report, March 1, 2005.) February 28, 2006.).

Howell, P. and P.J. Auster. 2012. Phase shift in an estuarine finfish community associated with warming temperatures. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science,* v. 4, p. 481-495.

ED_001437D_00000426-00139

Hunt, C.D. 1979. The role of phytoplankton and particulate organic carbon in trace metal deposition in Long Island Sound. Dissertation for Doctor of Philosophy at the University of Connecticut, unpublished.

Institute for Sustainable Energy. 2003a. Environmental Resources and Energy Infrastructure of Long Island Sound. Comprehensive Assessment and Report, Part II. Prepared by the Task Force on Long Island Sound. Pursuant to Public Act No. 02-95 and Executive Order No. 26 (June 3, 2003). Available at: http://www.easternct.edu/sustainenergy/taskForceWorkingGroup/AssessmentReport2.pdf

Institute for Sustainable Energy. 2003s. Existing & Proposed Infrastructure Crossings of Long Island Sound Marine Environment- Environmental Resource Maps. (Appendix C of Institute for Sustainable Energy. 2003a). Available at: http://www.easternct.edu/sustainenergy/taskForceWorkingGroup/LIS%20maps%20Coprehensive%20Report%20Part%20II/Report%20II%20Appendix%20C%20Table%20of%20Contents.htm

Kimbrough K.L., W.E. Johnson, G.G. Lauenstein, J.D. Christensen, and D.A. Apeti. 2009 An Assessment of Polybrominated Diphenyl Ethers (PBDEs) in Sediments and Bivalves of the US Coastal Zone. Silver Spring, MD. NOAA Technical Memorandum NOS NCCOS 9 4. 87p.

Knebel, H.J., R.P. Signell, R.R. Rendigs, L.J. Poppe, and J.H. List. 1999. Sea-Floor Environments in the Long Island Sound Estuarine System. *Marine Geology*, v.155, p. 277–318.

Knebel, H.J. and L.J. Poppe. 2000. Sea-Floor Environments within Long Island Sound – A Regional Overview. *Journal of Coastal Research.* Special Thematic Section, v.16, p. 535 – 550.

Lamborg, C.H., W.F. Fitzgerald, A. Skoog and P.T. Visscher. 2004 . The abundance and source of mercury-binding organic ligands in Long Island Sound. *Marine Chemistry,* v. 90, p. 151-163.

LISS (Long Island Sound Study). 2008. Sound Health 2008: A Report on the Status and Trends in the Health of the Long Island Sound.

LISS (____). 2013a. Water Quality Monitoring. Accessed on July 18, 2013: http://longislandsoundstudy.net/research-monitoring/water-quality-monitoring/

LISS (____). 2013b. Lobster Abundance. Accessed on July, 15, 2013: http://longislandsoundstudy.net/category/status-and-trends/living-marine-resources/

ED_001437D_00000426-00140

Long, E.R. and P. Chapman. 1985. A sediment quality triad: measurements of sediment contamination, toxicity, and infaunal community composition in Puget Sound. *Marine Pollution Bulletin,* v. 16, p. 405-415.

McMullen, K.Y., V.F. Paskevich, and L.J. Poppe. 2005. GIS Data Catalog (version 2.2). In: Poppe, L.J., S.J. Williams, and V.F. Paskevich (eds.), U.S. Geological Survey East-Coast Sediment Analysis: Procedures, Database, and GIS Data. *U.S. Geological Survey Open-File Report 2005-1001.* Available at: http://woodshole.er.usgs.gov/openfile/of2005-1001/htmldocs/datacatalog.htm

Mecray, E.L., Buchholtz ten Brink., M.R., and Shah, S., 2000, Metals in the Surface Sediments of Long Island Sound. In: Paskevich, V. and L.J. Poppe, (eds.), Georeferenced Sea-Floor Mapping and Bottom Photography in Long Island Sound: *U.S. Geological Survey Open-File Report 00-304*, Chapter 6. Available at: http://pubs.usgs.gov/of/2000/of00-304/htmldocs/chap06/index.htm.

Mecray, E. L. and M. R. Buchholtz ten Brink. 2000. Contaminant Distribution and Accumulation in the Surface Sediments of Long Island Sound. *Journal of Coastal Research,* v.16, p. 575–590.

Mecray, E.L., Reid, J.M., Hastings, M.E., and Buchholtz ten Brink, M.R., 2003, Contaminated Sediments Database for Long Island Sound and the New York Bight, U.S. Geological Survey Open-file Report No. 03-241. Available at: http://pubs.usgs.gov/of/2003/of03-241.

Mitch, A.A., 2006. Toxic Contamination in Long Island Sound: Update 2006. Yale University, School of Forestry and Environmental Studies. Available at: http://longislandsoundstudy.net/wp-content/uploads/2010/02/contaminant_update_finalreport.pdf

Morton, R.W., G.S. Cook, and M.T Massey. 1975. A summary of Environmental Data Obtained at the New London Dump Site and the East Hole, Block Island Sound. U.S. Naval Underwater Systems Center, Newport Laboratory.

Needell and Lewis, 1984, Geology of Block Island Sound, Rhode Island and New York, U.S. Geological Survey Miscellaneous Field Studies Map MF-1621. Included in: Geological Framework Data from Long Island Sound, 1981-1990: *U.S. Geological Survey Open-File Report 02-002.* A Digital Data Release. Available at: http://woodshole.er.usgs.gov/openfile/of02-002/htmldocs/bissum.htm

NFSC (Northeast Fisheries Science Center). 2008. EFH Source Documents: Life History and Habitat Characteristics.

NOAA (National Oceanographic and Atmospheric Administration) 2002. Geodatabase for NOAA Environmental Sensitivity Index. (NOAA National Ocean Service, Office of Response and Restoration, Rhode Island, Connecticut, New York, and New Jersey).

NOAA (____). 2013. Environmental Sensitivity Index (ESI) Maps. NOAA Office of Response and Restoration. Accessed on July 22, 2013 at: http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

O'Connor T.P. and G.G. Lauenstein . 2006. Trends in chemical concentrations in mussels and oysters collected along the US coast: Update to 2003. *Mar. Environ. Research* , v. 62, p. 261-285.

Olsen, S.B. and D.K. Stevenson. 1975. Commercial Marine Fish and Fisheries of Rhode Island. University of Rhode Island Coastal Resources Center. *URI Marine Technical Report 34.*

Olsen, C. and M. Lyman. 2003. Monitoring Long Island Sound Hypoxia 2002. Connecticut Department of Energy and Environmental Protection.

Olsen, C. and M. Lyman. 2005. Monitoring Long Island Sound Hypoxia 2004. Connecticut Department of Energy and Environmental Protection.

Olsen, C. and M. Lyman. 2008 . Connecticut Department of Environmental Protection Monitoring Long Island Sound Ambient Water Quality Monitoring Program: Overview and Analysis of Program Data. In: Proceedings of the Long Island Sound Research Conference held October 30-31, 2008 at Connecticut College, New London, CT, p. 14-18.

PAL, 2010. Cultural Resources Inventory Long Island Sound – Dredged Material Management Plan. Long Island Sound, Connecticut, New York, and Rhode Island. Technical Report, vol. I, Submitted to the U.S Army Corps of Engineers.

Pellegrino, P. and W. Hubbard. 1983. Baseline shellfish data for the assessment of potential environmental impacts associated with energy activities in Connecticut's coastal zone. Volumes I and II. Report to State of Connecticut, Department of Agriculture, Aquaculture Division, Hartford, CT. 177p.

Pearce, J. and N. Balcom. 2005. The 1999 Long Island Sound Lobster Mortality Event: Findings of the Comprehensive Research Initiative. *Journal of Shellfish Research*, v. 24, p. 691-697.

Poppe, L.J. and C. Polloni (eds.). 1998. Long Island Sound Environmental Studies . *U.S. Geological Survey Open-File Report 98-502.*

Poppe, L.J., H.J. Knebel, Z.L. Mlodzinska, M.E. Hastings, and B.A. Seekins. 2000a. Distribution of surficial sediment in Long Island Sound and adjacent waters: Texture and total organic carbon: Journal of Coastal Research, Thematic Section. Available at: http://pubs.usgs.gov/of/2000/of00-304/htmldocs/chap05/index.htm

ED_001437D_00000426-00142

Poppe, L.J., H.J. Knebel, and D.S. Blackwood. 2000b. Selected Bottom Photographs of Sedimentary Environments in Eastern Long Island Sound. In: Paskevich, V.F. and L.J. Poppe (eds.), Georeferenced Sea-Floor Mapping and Bottom Photography in Long Island Sound, *U.S. Geological Survey Open File Report 00-304,* Chapter 12. Available at: http://pubs.usgs.gov/of/of00-304/htmldocs/chap12/index.htm

Poppe, L.J., V.F. Paskevich, S.J. Williams, M.E. Hastings, J.T. Kelley, D.F. Belknap, L.G. Ward, D.M. FitzGerald, and P.F. Larsen. 2003. Surficial Sediment Data from the Gulf of Maine, Georges Bank, and Vicinity: A GIS Compilation. *U.S. Geological Survey Open-File Report 03-001*. Available at: http://pubs.usgs.gov/of/2003/of03-001/index.htm

Poppe, L.J., S.J. Williams, and V.F. Paskevich (eds.), U.S. Geological Survey East-Coast Sediment Analysis: Procedures, Database, and GIS Data. U.S. Geological Survey Open-File Report 2005-1001. Available at: http://woodshole.er.usgs.gov/openfile/of2005-1001/htmldocs/datacatalog.htm

Poppe, L.J., S.D. Ackerman, E.F. Doran, A.L. Beaver, J.M. Crocker, and P.T. Schattgen. 2006. Interpolation of Reconnaissance Multibeam Bathymetry from North-Central Long Island Sound. *U.S. Geological Survey Open-File Report 2005-1145.*

Poppe, L.J, S.J. Williams, M.S. Moser, N.A. Forfinski, H.F. Stewart, and E.F. Doran. 2008. Quaternary geology and sedimentary processes in the vicinity of Six Mile Reef, eastern Long Island Sound. *Journal of Coastal Research*, v. 24, p. 255–266.

Poppe, L.J., W.W. Danforth, K.Y. McMullen, C.E. Parker, and E.F. Doran. 2011. Combined Multibeam and LIDAR Bathymetry Data from Eastern Long Island Sound and Westernmost Block Island Sound – A Regional Perspective. *U.S. Geological Survey Open-File Report 2011–1003.*

Poppe, L.J., W.W Danforth, K.Y. McMullen, M.A. Blankenship, K.A. Glomb, D.B. Wright, and S.M. Smith. 2012a. Sea-Floor Character and Sedimentary Processes of Block Island Sound, Offshore Rhode Island. Prepared in cooperation with the National Oceanic and Atmospheric Administration. *U.S. Geological Survey Open-File Report 2012–1005*.

Poppe, L.J., R.N. Oldale, D.S. Foster, and S.M. Smith. 2012b. Glaciotectonic deformation associated with the Orient Point–Fishers Island moraine, westernmost Block Island Sound: further evidence of readvance of the Laurentide ice sheet. *Geo-Marine Letters*, v. 32, p. 279-288.

RICRMC (Rhode Island Coastal Resource Management Council). 2010. OCEAN SAMP – Rhode Island Ocean Special Area Management Plan (RI SAMP). (October 2010). Report available at: http://www.crmc.ri.gov/samp_ocean.html. Maps are also available at: http://www.narrbay.org/d_projects/oceansamp/papermap_mgeo.htm

RIDFW (Rhode Island Department of Environmental Management, Division of Fish and Wildlife). 2012 a. 2013 Management Plan for the Finfish Fishery Sector. Available at: http://www.dem.ri.gov/pubs/regs/regs/fishwild/mpfinfsh.pdf

RIDFW (____). 2012 b. 2013 Management Plan for the Crustacean Sector. Available at: http://www.dem.ri.gov/pubs/regs/regs/fishwild/mpcrust.pdf

RIDFW (____). 2012c. 2013 Management Plan for the Shellfish Fishery Sector. Available at: http://www.dem.ri.gov/pubs/regs/regs/fishwild/mpshell.pdf

Reid, R.N. 1979. Long term fluctuations in the mud-bottom macrofauna of Long Island Sound, 1972-1978. M.S. Thesis, Boston University, Boston, Massachusetts, 36p.

RIDOH (Rhode Island Department of Health). 2013. Mercury Poisoning: About Fish. Accessed on July 22, 2013 at: http://www.health.ri.gov/healthrisks/poisoning/mercury/about/fish/

Sanders, H.L. 1956. Oceanography of Long Island Sound. The biology of marine bottom communities. Bulletin of the Bingham Oceanographic Collection 15:345-415.

Sanudo-Wilhelmy, S. and C. Gobler. 2003. Trace Metals, Organic Carbon And Inorganic Nutrients In Surface Water of Long Island Sound: Sources, Cycling and Effects o n Phytoplankton Growth. Final Report. Available at: http://longislandsoundstudy.net/wp-content/uploads/2010/02/SanudoFinalReport.pdf

SAIC (Science Applications International, Inc.). 1996. Bathymetric and Subbottom Survey at the Cornfield Shoals Disposal Site, July 8, 1994. DAMOS Contribution Number 110. U.S. Army Corps of Engineers, New England District. Concord, MA. 18p.

SAIC (____). 2001a. Monitoring Cruise at the New London Disposal Site 1992-1998. Volume II Seawolf Mound. DAMOS Contribution Number 132. U.S. Army Corps of Engineers, New England District. Concord, MA.

SAIC (____). 2001b. Monitoring Cruise at the New London Disposal Site August 2000. DAMOS Contribution Number 133. U.S. Army Corps of Engineers, New England District. Concord, MA.

SAIC (____). 2003. Post-Storm Monitoring Survey at the New London Disposal Site Seawolf Mound October 2002. DAMOS Contribution Number 149. U.S. Army Corps of Engineers, New England District. Concord, MA.

SAIC (____), 2004. Monitoring Survey at the New London Disposal Site, June 2001. DAMOS Contribution #152. U.S. Army Corps of Engineers, New England District, Concord, MA . 119p.

Savard, W.L., 1966, The sediments of Block Island Sound: unpublished thesis, University of Rhode Island, Kingston, Rhode Island, 66p. (included in L.J Poppe et al., 2003, *U.S. Geological Survey Open-File Report 03-001,* SAVARD66: Sediments of Block Island Sound. Available at: http://pubs.usgs.gov/of/2003/of03-001/data/seddata/savard66/savard66.htm

Simpson, D. 2005. Semi-Annual Performance Report: Assessment and Monitoring of the American Lobster Resource and Fishery in Long Island Sound. Prepared for the National Marine Fisheries Service, Northeast Region. Available at: http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/lobdisaster05semi2.pdf

Skinner, L.C. M.W. Kane, K. Gottschall, and D.A. Simpson. 2009. Chemical Residue Concentrations in Four Species of Fish and the American Lobster from Long Island Sound, Connecticut and New York: 2006 and 2007. Prepared by New York State Department of Environmental Conservation (Division of Fish, Wildlife and Marine Resources) and Connecticut Department of Environmental Protection (Marine Resources Division).

Suffolk County. 2013. Suffolk County Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay. (June 15, 2011). Accessed on July 15, 2013 at: http://www.suffolkcountyny.gov/Portals/0/planning/EnvPlanning/Aquaculture/Map_SedGrSzDist.pdf

Tiner, R., H. Bergquist, T. Halavik, and A. MacLachlan. 2003. Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. National Wetlands Inventory report. 14p. Available at: http://library.fws.gov/Wetlands/eelgrass_report_v2.pdf

Tiner, R., H. Bergquist, T. Halavik, and A. MacLachlan. 2007. 2006 Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. National Wetlands Inventory report. 24p. plus Appendix.

Tiner, R., K. McGuckin, M. Fields, N. Fuhrman, T. Halavik, and A. MacLachlan. 2010. 2009 Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. National Wetlands Inventory report. 15p. plus Appendix.

USACE (U.S. Army Corps of Engineers) . 1981. Draft Programmatic Environmental Impact Statement for the Disposal of Dredged Material in the Long Island Sound Region. Prepared by the U.S. Army Corps of Engineers.

USACE (____). 2001. Dredging Needs Navigation-Dependent Facilities. Prepared by ENSR for the U.S. Army Corps of Engineers, New England District, Concord, MA under Contract No. DACW33-96-D-0004, Task Order 25, Mod. 14.

USACE (____), New England District. 2013. Dredged Material Management Plan. Available at: http://www.nae.usace.army.mil/Missions/ProjectsTopics/LongIslandSoundDMMP.aspx

USEPA and USACE (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers). 2004a. Final Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York. Prepared by the USEPA New England Region, in cooperation with the USACE New England District (April 2004).

USEPA and USACE (____). 2004b. Rhode Island Region Long-term Dredged Material Disposal Site Evaluation Project. Prepared by the USEPA New England Region, in cooperation with the USACE New England District (October 2004).

U.S. Navy. 1973. Submarine Naval Base, New London, Connecticut, Dredge River Channel. Environmental Impact Statement, Revised Draft Report. Prepared by Jason M. Cortell & Associates (May 1973).

Valente, R.M. and T.J. Fredette. 2002. Benthic recolonization of a capped dredged material mound at an open water disposal site in Long Island Sound. In: S. Garbaciak , Jr. (ed.), Dredging '02. Key Tec hnologies for Global Prosperity. Proceedings of the Third Specialty Conference on Dredging and Dredged Material Disposal, May 5-8, 2002. Orlando, Florida [CD]. New York, American Society of Civil Engineers, p. 46-51.

Varekamp, J., B. Kreulen, B.M. Buchholtz ten Brink, and E.L. Mecray. 2003. *Environmental Geology,* 43, 268-282.

Varekamp, J.C., M.R. Buchholtz ten Brink, E.L. Mecray, and B. Kreulen. 2000. Mercury in Long Island Sound Sediments. *Journal of Coastal Research*, v. 16, p. 613-626.

Ward, J.E., K. Strychar, K., and G.H. Wikfors. 2005. Phytoplankton Dynamics in Long Island Sound: Influence of Environmental Factors on Naturally Occurring Assemblages (EPA Grant # X 98 1613-01-1). Available at: http://longislandsoundstudy.net/wp-content/uploads/2010/02/Ward-EPA-Final-Report.pdf

WHG (Woods Hole Group). 2010. Long Island Sound Dredged Material Management Plan (DMMP) Phase 2 Literature Review Update. USACE Contract W912WJ-09 -D-0001, TO 0022 (June 2010)

Yang, L., X. Li, P. Zhang, M.E. Melcer, Y. Wuc, and U. Jans. 2011. Concentrations of DDTs and dieldrin in Long Island Sound sediment. *Journal of Environmental Monitoring.,* v. 14, p. 878-885.

Zajac, R.N. 1998. A Review of Research On Benthic Communities Conducted In Long Island Sound and An Assessment of Structure and Dynamics. Chapter 4, in Poppe, L.M., and C. Polloni (Eds.) *Long Island Sound Environmental Studies.* U.S. Geological Survey Open-

ED_001437D_00000426-00146

File Report 98-502, Chapter 4, CD-ROM. URL: http://pubs.usgs.gov/of/of98-502/chapt4/rz1cont.htm.

Zajac, R., R.S. Lewis, L.J. Poppe, D.C. Twichell, J. Vozarik, and M.L. DiGiacomo-Cohen, 2000a, Benthic Community Geographic Information Systems (GIS) Data Layers for Long Island Sound. In: Paskevich, V.F. and L.J. Poppe (eds.), Georeferenced Sea-Floor Mapping and Bottom Photography in Long Island Sound, USGS Open-File Report 00-304, Chapter 10. Available at: http://pubs.usgs.gov/of/of00-304/htmldocs/chap10/index.htm

Zajac, R.N., R.S. Lewis, L.J. Poppe, D.C. Twichell, J. Vozarik, and M.L. DiGiacomo-Cohen. 2000b. Relationships among sea-floor structure and benthic communities in Long Island Sound at regional and benthoscape scales. Journal of Coastal Research, v. 16, p. 627-640.

[This page intentionally left blank.]

ED_001437D_00000426-00148

Appendix A

Documents in WHG (2010) with direct Applicability to Eastern Long Island Sound SEIS

(Source: Compiled by Battelle [2013] with minor modifications)

ED_001437D_00000426-00149

[This page intentionally left blank.]

¶

┘ µ ö Z }	å ê d] ö o	z W µ ö	W å] u d } â]	┐W åå «┘ ┼d └} Ì â	^ µ	ö ^} µâ]	↑ } ┼ ö └ }d Ìâ«] â																																							
↑ ' µ] ê └U└	>/X v ¿] â } v u v ö	└ Ó └ ö	↑Ï └ Û }ö o ┐} ┐ v → └ ^	^ « v ö	Z ö Zê]	æ └ , ┐	W] oö ┐┐ v ö & µ ö µ				y																											y							y		
o â Z] ┼ I └U └ ↕ } u] v ê └U└W└ X	^ ┐ o ö └D ┐ â ê Z └r◀ â ^ } µ v → └W└ ^ ö ┐ ö µ ê / u â } â ö ┐ v ö └ ^ â	└ Ó └ Ï	Ï └Ò } o } ┐ v → └ ^		D ┐ â ê	◀] æ →	Z ê â } â µ							y							y											y					y	y						y		
E^Z	D } v] ö } â] v P └ ^ µ â ↑] ê â } ê ┐ o └ ^] ö	└ Ó └ Ï	, Ï } Òê ö } ┘ ┼ ö] ¿ ↑ µ u â └ ^	^ →]	W Z «v êö	◀ ┼} ┐ö oö D } â â	Z (â } â µ		y															y												y				y	y	y				
& → â ┐ o └ ↕ } u u] ê ê]	>] ê ö └ K (└D ┐ i } â └W D ┐ « └ └ Ì └ Ù └U └ └ Ó └ Ï └ Ï └ ı	└ Ó └ Ï	' Ï └ ıv â	┐ o └ / v	ö â	ê ö	↑ ┐ ö ┐ └ ~ â µ				y																				y												y			
&] ö Ã P â ┐ W└ Xd└ X	&] v ┐ o └ Z â } â ö └W W Z « ê] ┼ } ┼ Z u] d Z └ ↕ } ┐ ê ö ┐ o └ I ^ } µ v → └ ┘ v → └ / ö ê └ Z	└ Ó └ Ï	' Ï └ Ó} o } ' } u }	t ┐ ö	' â └ Y} µ ┐	D o]uöö] ┐	Z o öê â « â µ				y										y																					y			y		
& â → ö ö	h └U └d └ X: └ Xá U└ê ┐ö v → v & â] ↕ } v ê ã µ v ┼ ,] ê ö } â « └ / v └ E i	└ Ó └ Ï	Z └ U□ ¿ Xd└ X ¿ ┐ o µ ┼ } v } ↑] ê â }		d ê ö ¿ ┐ o v ¿]		: } µ â				y																	y				y				y				y	y	y				
& µ ê ê └ └ ò └ K └ [E , } o └ ' â } µ	v ¿] â } v u v ö ┐ , ┐ u u } v ┐ ê ê ö └ ◀	└ Ó └ Ï	↕ Ï └} Ù ┐ ê ö D ┐ v ┐ P	W µ o W ┐ â I ◀ ┐ ┼ ^ ┐ v ┼	â } ê ^ →]	W µ o	Z ┼ └ ◀ } â µ							y						y													y						y						y		
' } o â └U └ ↕ └ D └ X └ X └ ┐ v → └ ^	E] ö â } P v └ ┘ v → └ ^ ↕ } u u µ v] ö] ê └ ┘ Z] ¿ â └ r> } v P └ / ê o	└ Ó └ Ï	t Ï ┼ Úö â	└ Y µ ┐	W ö ö « Y µ ┐ o	E µ ö â	:] } µ v â ö				y														y																				y		
' } â } I Z } ¿] s } µ ê ö] ┐ v	W â] } â] ö] Ã ┐ ö] ↕ } v ê â ¿ ┐ ö] }	└ Ó └ Ï	↕ Ï └} ı ┐ ê ö D ┐ v ┐ P		> ┐ v → └	h ê	: } µ â								y							y																									
, ┐ u u â ê ┼ &] ö Ã P â ┐ ◀ ┐ o ┼ } u └U └W └	◀] } P } ┼ Z u] ê K (└ > } v P └ / ê o ┐ v → └ ^	└ Ó └ Ï	^ Ï └ □→] u	v ö	^ →] ↕ Z u		: } µ â				y										y																									y		
, } o ê ö └ ┐ v →	^└ zµ } âµ (v┐P ┼ └ o ¿	└ Ó ö Ï	Ï} └Ô } o } ┐ v → └ ^	o ê	D ┐ â ê	Z ê	W o ┐ v & µ ö µ								y									y																					y		

/ v ê ö] ö µ ö	Δ (] }ê åö ^] µv e öö W]å v > } v P / ê o v → ^ } µ D u u o ê	Ó	Doï Ô å]v v v → v ^ å]	å P «	,]	ö ö	D å ê	I Z å ö ê y	y	y y y y
/ v ê ö] ö µ ö d ê I & } å	} u å å Z v ê] ¿ v ¿] å } v u v ö / v (å ê ö å µ ö > } v P / ê o v → ^ } µ W å } P å u ê	Ó Ï	' Ï Ôv å	o / v	ö å	ê ö	Z å } å µ	y	] å	ö } å «
<] v P U : Xt X	Z Z } → / ê o v → K ã µ] ê Z ê µ o	Ó Ï	WÏZ Ù« ê] K v	^ →]	^u v b d å v	} ö ö D } å å	} v (W å }	y	y	y y
> u } å P ^ I } } P U X	d Z µ v → v K å P v] >] P v	Ó Ï	' Ï } o } ' } u }	t ö	' å Y} µ	D o]uöö]	ê o }ö ê µå å«	v o W å å y	y	y y
> i å v t] o o] u ê U & } å ( ] v ê I v → } å	Y µ ö å v å « ' / v d Z s]] v] ö « / ê o v → ^ } µ v →	Ó Ï	^ Ï Ù→] u	' v }ö o ' } u «	W Z « ê K	^ →] d å v	: } µ å	v o W å å y	y	y y
> U z X: X	/ w →ö > ¡å] Ã v v U < X o s ^ o] v] ö « / v ^ Z E ¡ z } å I	Ó Ï	t Ï Òö	å Y µ	ö]o öö « ~ Y µ o		: } µ å	v o W å å y	y	y
> } v P / ê o v	Z→ ^ ê} ö µ v å } vö P µ> } v«	Ø êï	öÏ }Óv →ê ^ö D v P	} µ v o ,] ^ å	^ ñZ å	K öö]]Z vö	Då ö ê	I ö Z å ö ê y	] å	ö } å « y y y
> } v P / ê o v	^→} ^µ }v µ→ v , → ^ ö o µö →Z « d å v → ê / v d Z ,	Ó Ï	& Ï Ùê Z &] ê Z	t ö	å o Yo µ ~&] ê &] ê Z	o]] êö ê K Δ « P	Z å } å µ	y	y	y
D] ö Z U X	d X } Δ] } v ö u] h å → ö	Ó Ï	& Ï Úê Z] v → , Z] ê I ê	^ →]	u } vv öö	^ u] v] Z u	Z v öå å µ	y	ö } u	y
D µ ê Z I	YU µ& X v ö] ö ö] ¿ s P ö ö] ¿ d] ê ö å] ö t] ö W } v] «	Ó Ï	Ï Û } o } v → ^		D å ê	Z ê	Z å } å µ	y y		y y y
E ö] } v o ^ å ¿]	] v å µ v o &] êv Z] å K (Ó r å å r Ï ı	]Ó Ï	&Ï ıê Z &] ê Z		} v ~ ö ((} å		ö	Z å } å ö y	y	
E ¡ v P o D v P u	ê ê v ö] o &] ê ~ ' → µ ê D } å Z µ	Ì ı	& ı Ùê Z &] ê Z		ê ê &] ê Z ,]		Z å } å µ	y	y	y y y y

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
New England Fishery Management Council	Essential Fish Habitat Description Atlantic Halibut (Hippoglossus Hippoglossus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Atlantic Herring (Clupea Harengus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Monkfish (Lophius Americanus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Ocean Pout (Macrozoarces Americanus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Pollock (Pollachius Virens)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Red Hake (Urophycis Chuss)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Windowpane Flounder (Scophthalmus Aquosus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Winter Flounder (Pleuronectes Americanus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Witch Flounder (Glyptocephalus Cynoglossus)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England Fishery Management Council	Essential Fish Habitat Description Yellowtail Flounder (Pleuronectes Ferruginea)	1998	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Report (final, published)				X									X											X	X					X						X	X		
New England FisheryManagement Council	Essential Fish HabitatDescription Haddock (Melanogrammus Aeglefinus)	1998	Fisheries/Shell Fisheries		Essential Fish Habitat		Report (final, published)				X									X											X	X					X						X	X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
New York State Department of Environmental Conservation	Beneficial Use Determinations (BUDS)	2009	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	Alternative Methods-Environmental	New York	Website								X														X																	
New York State Department of Environmental Conservation	Region 3 Upland Disposal/Management Of Dredged Sediments	2009	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	Alternative Methods-Environmental	New York	Website								X														X																	
New York State Department of Environmental Conservation	Tidal Wetlands	2010	Ecology, Habitats and Species		Marshes		Website				X																	X				X						X						X		
New York State Department of Environmental Conservation and Connecticut Department of Environmental Protection	A Total Maximum Daily Load Analysis To Achieve Water Quality Standards For Dissolved Oxygen In Long Island Sound	2000	Water Quality		Nutrients		Report (final, published)				X																		X			X														
New York State Department of Environmental Conservation, Division of Solid & Hazardous Materials	Active Long Island Landfills	2008	Coastal Management		Land Use		Database (published)											X												Directory																
NOAA National Ocean Service, Office of Response and Restoration	Rhode Island, Connecticut, New York, and New Jersey ESI	2002	Coastal Management	Ecology, Habitats and Species	Shoreline	Other Habitats	Maps/Charts				X									X												X				X	X	X					X	X		
NOAA Office of Ocean & Coastal Resource Management	National Coastal Program Dredging Policies An Analysis Of State, Territory, & Commonwealth Policies Related To Dredging & Dredged Material Management	2000	State Dredged Material Disposal Guidance		All (State Guidance)		Report (final, published)				X																	X																		
Northeast Fisheries Science Center	EFH Source Documents: Life History And Habitat Characteristics	2008	Fisheries/Shell Fisheries		Essential Fisheries Habitats		Website				X									X											X	X					X						X			
Olsen, C. and Lyman, M.	Monitoring Long Island Sound Hypoxia 2002	2003	Water Quality		All (Water Quality)		Data Report				X													X																				X		
Olsen, C. and Lyman, M.	Monitoring Long Island Sound Hypoxia 2004	2005	Water Quality		All (Water Quality)		Data Report				X													X																				X		
Paskevich, V.F. and Poppe, L.J.	Georeferenced Sea-Floor Mapping And Bottom Photography In Long Island Sound	2000	Sediment		Sediment Chemistry	Bottom Morphology	Report (final, published)				X										X																							X		
Pearce, J. and Balcom, N.	The 1999 Long Island Sound Lobster Mortality Event: Findings Of The Comprehensive Research Initiative	2005	Fisheries/Shell Fisheries	Water Quality	Thermal Pollution	Lobster	Journal Paper				X									X																								X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
Petruny-Parker, M., Boyd, J., Rubinstein, N., Carey, D., and August, P.	Coastal Institute Working Group Review Of The Siting Criteria For An Offshore Long-Term Dredged Material Disposal Site(S) For The Rhode Island Region	2003	Environmental Evaluation and Economics of Disposal Options		Alternative Sites-Environmental		Report (final, published)	X												X											X	X		X	X	X	X	X		X	X	X	X	X		X
Pleasant, A. , Zarcadoolas, C. , Engelman, A. , Thorpe, M. and Lerner, J.	An Exploratory Study Of Public Knowledge And Perceptions Of Dredging And Reuse Of Dredged Materials	2004	General Interest				Conference Proceedings									X														Forum for current research																
Poppe, L.J., and Polloni, C.	Long Island Sound Environmental Studies	1998	Geology and Geomorphology	Sediment	All (Sediment)	All (Geology)	Report (final, published)				X										X											X		X					X		X			X		
Poppe, L.J., Denny, J.F., Williams, S.J., Moser, M.S., Stewart, H.F., Forfinski, N.A., and Doran, E.F.	The Geology Of Six Mile Reef, Eastern Long Island Sound	2007	Sediment		Bottom Morphology		Report (final, published)			X											X																							X		
Poppe, L.J., DiGiacomo-Cohen, M.L., Smith, S.M., Stewart, H.F. and Forfinski, N.A.	Seafloor Character And Sedimentary Processes In Eastern Long Island Sound And Western Block Island Sound	2006	Geology and Geomorphology	Physical Oceanographic	Sediment Transport	Seismic Profiles	Journal Paper			X											X											X		X							X					
Poppe, L.J., DiGiacomo-Cohen, M.L., Smith, S.M., Stewart, H.F., and Forfinski, N.A.	Geological Interpretation And Multibeam Bathymetry Of The Sea Floor In The Vicinity Of The Race, Eastern Long Island Sound	2007	Sediment		Bottom Morphology		Report (final, published)			X											X																							X		
Poppe, L.J., Paskevich, V.F., Lewis, R.S., and DiGiacomo-Cohen, M.L.	Geological Framework Data From Long Island Sound, 1981-1990: A Digital Data Release	2002	Geology and Geomorphology		Volumes and Types of Material		Data Report				X										X											X		X					X		X			X		
Poppe, L.J., Paskevich, V.F., Williams, S.J., Hastings, M.E., Kelly, J.T., Belknap, D.F., Ward, L.G., Fitzgerald, D.M., and Larsen, P.F.	Surficial Sediment Data from the Gulf of Maine, Georges Bank, and Vicinity: A GIS Compilation	2003	Sediment		Physical Characteristics		Report (final, published)	X													X																							X		
Preston, J.	Connecticut River Riparian Area Mapping	2004	Ecology, Habitats and Species		Vegetation		Maps/Charts										X			X																	X							X		
Rhode Island Department of Environmental Management	Rules And Regulations For Dredging And The Management Of Dredged Material	2003	State Dredged Material Disposal Guidance		Rhode Island		Report (final, published)									X													X																	
Rhode Island Department of Environmental Management, Division of Fish and Wildlife - Marine Fisheries	2010 Management Plan For The Crustacean Sector	2009	Fisheries/Shell Fisheries		All (Fisheries/Shell Fisheries)		Report (final, published)	X																					X		X	X					X						X	X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
Rhode Island Department of Environmental Management, Division of Fish and Wildlife - Marine Fisheries	2010 Management Plan For The Finfish Fishery Sector	2009	Fisheries/Shell Fisheries		All (Fisheries/Shell Fisheries)		Report (final, published)	X																					X		X	X					X						X	X		
Rhode Island Department of Environmental Management, Division of Fish and Wildlife - Marine Fisheries	2010 Management Plan For The Shellfish Fishery Sector	2009	Fisheries/Shell Fisheries		All (Fisheries/Shell Fisheries)		Report (final, published)	X																					X		X	X					X						X	X		
SAIC	Post-Storm Monitoring Survey At The New London Disposal Site Seawolf Mound October 2002	2003	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	Bottom Morphology	Report (final, published)			X														X												X				X	X	X				
Sanudo-Wilhelmy, S. and Gobler, C.	Trace Metals, Organic Carbon And Inorganic Nutrients In Surface Water Of Long Island Sound: Sources, Cycling And Effects On Phytoplankton Growth	2003	Water Quality		Nutrients	Metals	Report (final, published)				X										X																							X		
Simpson, D.	Semi-Annual Performance Report: Assessment And Monitoring Of The American Lobster Resource And Fishery In Long Island Sound	2005	Fisheries/Shell Fisheries		Lobster		Data Report				X													X													X							X		
Skinner, L.C., Kane, M.W., Gottschall, K., and Simpson, D.A.	Chemical Residue Concentrations In Four Species Of Fish And The American Lobster From Long Island Sound, Connecticut And New York: 2006 And 2007	2009	Fishing Activities and Human Health Risks		Contaminants		Report (final, published)				X										X																X							X		
Stacey, P., and Beristain, M.	Toxic Contamination In Long Island Sound	1990	Fishing Activities and Human Health Risks	Sediment	Sediment Chemistry	Contaminants	Brochure				X																			Data comparison											X			X		
State of Connecticut Department of Agriculture	Leasing Oyster And Clam Grounds	2009	Fisheries/Shell Fisheries		Oysters	Aquaculture/Commercial Area	Website							X															X																	
State of Connecticut Department of Agriculture	New Shellfish Bed Lease Opportunities	2009	Fisheries/Shell Fisheries		Oysters	Aquaculture/Commercial Area	Website							X																Directory	X						X						X			
Stony Brook University Center for Survey Research	Public Perception Survey Of Long Island Sound Watershed Residents	2006	Coastal Management	Water Quality	Land Use	Nutrients	Report (final, published)				X																			Data Comparison																
Sustainable Long Island	Brownfield Sites By Community		General Interest				Maps/Charts											X												Directory																

ED_001437D_00000426-00158

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
Tiner, R., Bergquist, H., Halavik, T., and MacLachlan, A.	2006 Eelgrass Survey For Eastern Long Island Sound, Connecticut And New York	2007	Ecology, Habitats and Species		Submerged Aquatic Vegetation		Report (final, published)			X											X										X	X					X						X	X		X
Tiner, R., Bergquist, H., Halavik, T., and MacLachlan, A.	Eelgrass Survey For Eastern Long Island Sound, Connecticut And New York	2003	Ecology, Habitats and Species		Submerged Aquatic Vegetation		Report (final, published)			X											X										X	X					X						X	X		X
U.S. Environmental Protection Agency and U.S. Army Corps of Engineers	Environmental Impact Statement For The Designation Of Dredged Material Disposal Sites In Central And Western Long Island Sound, Connecticut And New York	2004	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Report (final, published)				X									X																										
U.S. Environmental Protection Agency Region 1 and U.S. Army Corps of Engineers New England District	Regional Implementation Manual For The Evaluation Of Dredged Material Proposed For Disposal In New England Waters	2004	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	Testing and Evaluation-Environmental	All (State Guidance)	Report (final, published)				X																		X											X						
US Fish & Wildlife	Threatened & Endangered Species System: Environmental Conservation Online System - Connecticut	2009	Ecology, Habitats and Species	Marine Wildlife and Endangered Species	Species Inventory	Federal Status	Database (published)										X													Directory							X							X		
US Fish & Wildlife	Threatened & Endangered Species System: Environmental Conservation Online System - New York	2009	Ecology, Habitats and Species	Marine Wildlife and Endangered Species	Species Inventory	Federal Status	Database (published)											X												Directory							X							X		
Valente, R.M. and Fredette, T.J.	Benthic Recolonization Of A Capped Dredged Material Mound At An Open Water Disposal Site In Long Island Sound	2002	Bethic (Macro Invertebrates)	Historic Disposal Activities and Dump Sites			Conference Proceedings			X											X																					X		X		
Varekamp, J., Kreulen, B., ten Brink, B.M., and Mecray, E.	Mercury Contamination Chronologies From Connecticut Wetlands And Long Island Sound Sediments	2003	Geology and Geomorphology	Sediment	All (Geology)	Sediment Chemistry	Journal Paper				X										X																				X			X		
Varekamp, J.C., Mecray, E.L. and Maccalous, T.Z.	Once Spilled, Still Found: Metal Contamination In Connecticut Coastal Wetlands And Long Island Sound Sediment From Historic Industries	2005	Sediment		Sediment Chemistry		Book				X																	X																X		
Varekamp, J.C., Thomas, E., Altabet, M., Cooper, S., and Brinkhuis, H.	Environmental Change In Long Island Sound In The Recent Past: Eutrophication And Climate Change	2010	Sediment	Water Quality	All (Sediment)	Nutrients	Report (final, published)				X									X																								X		
Vorros, A.	Dredged Materials In Abandoned Coal Mine Reclamation	2005	Coastal Management	Environmental Evaluation and Economics of Disposal Options	Alternative Methods-Environmental	Land Use	Conference Proceedings								X															Forum for current research																

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Block Island	Cornfield Shoals	Eastern Long Island	Entire LIS	Gardiners & Peconic Bays	New London	Shoreline CT	Shoreline NY	Shoreline RI	Upland CT	Upland NY	Other	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline Characterization	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified	40 CFR 228.5 a	40 CFR 228.5 b	40 CFR 228.5 c	40 CFR 228.5 d	40 CFR 228.5 e	40 CFR 228.6 (a) 1	40 CFR 228.6 (a) 2	40 CFR 228.6 (a) 3	40 CFR 228.6 (a) 4	40 CFR 228.6 (a) 5	40 CFR 228.6 (a) 6	40 CFR 228.6 (a) 7	40 CFR 228.6 (a) 8	40 CFR 228.6 (a) 9	40 CFR 228.6 (a) 10	40 CFR 228.6 (a) 11
Ward, J.E., Strychar, K., and Wikfors, G.H.	Phytoplankton Dynamics In Long Island Sound: Influence Of Environmental Factors On Naturally Occurring Assemblages (EPA Grant # X 98 1613-01-1)	2005	Water Quality		All (Water Quality)	Plankton	Report (final, published)				X										X																X							X		
Yozzo, D.J., Wilber, P., and Will, R.J.	Beneficial Use Of Dredged Material For Habitat Creation, Enhancement, And Restoration In New York–New Jersey Harbor	2004	Ecology, Habitats and Species	Environmental Evaluation and Economics of Disposal Options	Alternative Methods-Environmental	Other Habitats	Journal Paper								X															Data comparison																
Zajac, R.N., Seals. K., and Simpson, D.	Food Webs In Long Island Sound: Review, Synthesis And Potential Applications	2008	Ecology, Habitats and Species		Other Habitats		Report (final, published)				X												X														X							X		

Appendix B

Documents in WHG (2010) with indirect Applicability to the Eastern Long Island Sound SEIS

(Source: Compiled by Battelle [2013] with minor modifications)

[This page intentionally left blank.]

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Banslaben, J., Cox, J.C., and Will, R.J.	Beneficial Use Of Dredged Bedrock In The New York/New Jersey Harbor	2003	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Report (final, published)	Outside Study Area									X		
Baxter, C.D.P., King, J.K., Silva, A.J., Page, M., and Calabretta, V.V.	Site Characterization Of Dredged Sediments And Evaluation Of Beneficial Uses	2004	Environmental Evaluation and Economics of Disposal Options	Sediment	Testing and Evaluation-Environmental	Physical Characteristics	Journal Paper	Outside Study Area			X								
Beaulieu, E., Poppe, L.J., Paskevich, V.F., Doran, E.F., Chauveau, B.E., Crocker, J.M., Beaver, A.L., and Schattgen, P.T.	Sidescan Sonar Imagery And Surficial Geologic Interpretation Of The Sea Floor Off Bridgeport, Connecticut	2005	Sediment		Bottom Morphology	Physical Characteristics	Report (final, published)	Western LIS		X									
Bolam, S.G., and Rees, H.L.	Minimizing Impacts Of Maintenance Dredged Material Disposal In The Coastal Environment: A Habitat Approach	2003	Environmental Evaluation and Economics of Disposal Options	Benthic (Macro-Invertebrate) Resource	Testing and Evaluation-Environmental		Journal Paper	N/A									X		
Bolam, S.G., Schratzberger, M., and Whomersley, P.	Macro- And Meiofaunal Recolonisation Of Dredged Material Used For Habitat Enhancement: Temporal Patterns In Community Development	2006	Environmental Evaluation and Economics of Disposal Options	Benthic (Macro-Invertebrate) Resource	Alternative Methods-Environmental		Journal Paper	Outside Study Area		X									
Bourque, A.S., Pederson, J., and Shine, J.	Biological And Chemical Analyses Of Boston Harbor Confined Aquatic Disposal Cells	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Conference Proceedings	Outside Study Area		X									
Brandon, D.L., and Price, R.A.	Summary Of Available Guidance And Best Practices For Determining Suitability Of Dredged Material For Beneficial Uses	2008	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	Alternative Methods-Environmental	All (State Guidance)	Report (final, published)	N/A										X	
Bunch, B.W., Channell, M., Corson, W.D., Ebersole, B.A., Lin, L., Mark, D.J., McKinney, J.P., Pranger, S.A., Schroeder, P.R., Smith, S.J., Tillman, D.H., Tracy, B.A., Tubman, M.W., and Welp, T.L.	Evaluation Of Island And Nearshore Confined Disposal Facility Alternatives, Pascagoula River Harbor Dredged Material Management Plan	2003	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Report (final, published)	Outside Study Area				X							

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Burt, T.N. (Ports and Estuaries Group at HR Wallingford)	Guidelines For The Beneficial Use Of Dredged Material	1996	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	All (State Guidance)	Alternative Methods-Environmental	Report (final, published)	N/A										X	
Cerrato, R.M. and Holt, L.	North Shore Bays Benthic Mapping: Groundtruth Studies	2008	Benthic (Macro-Invertebrate) Resource	Sediment	Bottom Morphology		Report (final, published)	Western LIS	X										
Chang, T.J., Bayes, T.D., and McKeever, S.	Selection Of Wetland Sites For Reservoir Dredging Materials At Charles Mill Lake Of Ohio	2000	Environmental Evaluation and Economics of Disposal Options	Sediment	Alternative Sites-Environmental	Physical Characteristics	Conference Proceedings	Outside Study Area	X										
Cieniawski, S. and Tuchman, M.	The Use Of Innovative Sediment Treatment Technologies In The Great Lakes	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental	Testing and Evaluation-Cost	Abstract	Outside Study Area			X								
Comoss, E.J., Kelly, D.A., and Leslie, H.Z.	Innovative Erosion Control Involving The Beneficial Use Of Dredged Material, Indigenous Vegetation And Landscaping Along The Lake Erie Shoreline	2000	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Conference Proceedings	Outside Study Area											Forum for current research
Costa-Pierce, B.A. and Weinstein, M.P.	Use Of Dredge Materials For Coastal Restoration	2002	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Methods-Environmental	Marshes	Journal Paper	Outside Study Area									X		
Crannell, B., Eighmy, T.T., Butler, L., Emery, E., and Cartledge, F.	Use Of Phosphate To Stabilize Heavy Metals In Contaminated Sediments	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Conference Proceedings	Outside Study Area			X								
Creef, E., Hennington, S.M., and Mathies, L.G.	Beneficial Use Of Dredged Materials: Part Of The Solution To Restoration Of Louisiana'S Coastal Wetlands	2000	Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Abstract	Outside Study Area									X		

ED_001437D_00000426-00164

Authors	Title	Year of Publication	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Cuomo, C. and Valente, R.	Monitoring Of Bottom Water And Sediment Conditions At Critical Stations In Western Long Island Sound	2003	Benthic (Macro-Invertebrate) Resource	Water Quality	All (Water Quality)		Report (final, published)	Western LIS					X						
Cura, J.J., Bridges, T.S., and McArdle, M.E.	Comparative Risk Assessment Methods And Their Applicability To Dredged Material Management Decision-Making	2004	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Journal Paper	N/A									X		
Dalton, J.L., Gardner, K.H., Seager, T.P., Weimer, M.L., Spear, J.C.M., and Magee, B.J.	Properties Of Portland Cement Made From Contaminated Sediments	2004	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental	Testing and Evaluation-Cost	Journal Paper	N/A			X								
Douglas, W.S., Baier, L.J., Gimello, R.J., and Lodge, J.	A Comprehensive Strategy for Managing Contaminated Dredged Material in the Port of NY and NJ	2003	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Journal Paper	Outside Study Area									X		
Douglas, W.S., Dunlop, P., and Jafari, F.	Constructing And Maintaining The Port Of NY And NJ, USA: Operational And Management Challenges In Moving From Disposal To Beneficial Use	2006	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Conference Proceedings	Outside Study Area									X		
Douglas, W.S., Maher, A., and Jafri, F.	Dredged Material from New York/New Jersey Harbor, USA, for Construction of Roadway Embankments	2005	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Journal Paper	Outside Study Area		X									
East-West Gateway Coordinating Council of Governments	Highway Runoff And Water Quality Impacts	2000	Water Quality	Coastal Management	All (Water Quality)	Land Use	Report (final, published)	Outside Study Area									X		
Eeenhoorn, H. and van der Sluijs, W.	Handling And Treatment Of Contaminated Sediments In The Netherlands	2000	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Conference Proceedings	N/A									X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
ENSR	Baseline Bathymetric Surveys At The Central And Western Long Island Sound Disposal Sites, July 2005.	2007	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	Bottom Morphology	Report (final, published)	Central LIS					X						
ENSR	Monitoring Survey At The Central Long Island Sound Disposal Site, June 2004.	2005	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	Bottom Morphology	Report (final, published)	Central LIS					X						
ENSR	Monitoring Survey at the Central Long Island Sound Disposal Site, September 2003.	2004	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	Bottom Morphology	Report (final, published)	Central LIS					X						
ENSR	Monitoring Survey At The Western Long Island Sound Disposal Site, June 2004.	2005	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	Bottom Morphology	Report (final, published)	Western LIS					X						
ENSR	Stamford-New Haven North/Cap Site 2 Investigation May 2004.	2005	Historic Disposal Activities and Dump Sites	Sediment	Physical Effects	All (Sediment)	Report (final, published)	Central LIS					X						
Estes, T. J., Waugh, J., Schwartz, R. L., Green, G., Buhr, V., Braddock, B., and Detzner, H.-D.	Mechanical Dewatering Of Navigation Sediments: Equipment, Bench-Scale Testing, And Fact Sheets	2004	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental	Alternative Methods-Cost	Report (final, published)	N/A									X		
Federal Energy	Broadwater LNG Project Final Environmental Impact Statement	2008	Ecology, Habitats and Species	Sediment	Species Inventory	All (Sediment)	Report (final, published)	Central LIS	X										
Field, L., MacPherson, G., and Lundy, K.	The Capping Proposal For Cell 1, Tommy Thompson Park - A Wetland Creation Opportunity On The Toronto Waterfront	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Abstract	Outside Study Area			X								
G.E.C., Inc.	Calcasieu River And Pass, Louisiana Dredged Material Management Plan And Supplemental Environmental Impact Statement	2009	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental	Alternative Methods-Cost	Report (draft)	Outside Study Area	X										

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Gaffney, R.	Dredged Material:What To Do With It? Cost-Effective Beneficial Use Of Dredged Material	2005	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Cost		Conference Proceedings	Outside Study Area			X								
Gahagan & Bryant Associates, Inc.	Poplar Island Restoration Project Beneficial Use Of Dredged Material	2004	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Methods-Environmental	Marshes	Conference Proceedings	Outside Study Area											Forum for current research
Germano, J. D., and Cary, D.	Rates And Effects Of Sedimentation In The Context Of Dredging And Dredged Material Placement	2005	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Report (final, published)	N/A									X		
Goebel, N.L. and Kremer, J.N.	Temporal And Spatial Variability Of Photosynthetic Parameters And Community Respiration In Long Island Sound	2007	Water Quality		Plankton (Water Quality)		Journal Paper	Central LIS					X						
Goebel, N.L., Kremer, J.N. and Edwards, C.A.	Primary Production In Long Island Sound	2006	Water Quality		Plankton (Water Quality)		Journal Paper	Central LIS					X						
Great Eastern Ecology, Inc.	Norton Basin/Little Bay Statistical Analysis Preliminary Project Report And Summary Of Data Analyses	2004	Benthic (Macro-Invertebrate) Resource	Water Quality	All (Water Quality)		Report (draft)	Outside Study Area		X									
Guilfoyle, M.P., Fischer, R.A., Pashley, D.N., and Lott, C.A.	Summary Of First Regional Workshop On Dredging, Beach Nourishment, And Birds On The South Atlantic Coast	2006	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Methods-Environmental	Birds	Report (final, published)	Outside Study Area											Forum for current research
Gurfinkel, A.	ETHEC Industries - Integrated ETHEC Technology		Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Brochure	N/A									X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Henningson, J.C.	Claremont Channel Deepening: A Public Private Partnership Success Story	2000	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Conference Proceedings	Outside Study Area									X		
Hoogewerff, G.J.	Dredging And Disposal Of Contaminated Sediment In The Netherlands	2000	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Conference Proceedings	N/A									X		
Kane-Driscoll, S.B., Wickwire, W.T., Cura, J.J., Voorhees, D.J., Butler, C.L., Moore, D.W., and Bridges, T.S.	A Comparative Screening-Level Ecological And Human Health Risk Assessment For Dredged Material Management Alternatives In New York/New Jersey Harbor	2002	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Journal Paper	Outside Study Area	X										
Kiker, G.A., Bridges, T.S., and Kim, J.	Integrating Comparative Risk Assessment With Multi-Criteria Decision Analysis To Manage Contaminated Sediments: An Example For The New York/New Jersey Harbor	2008	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Journal Paper	Outside Study Area									X		
Lawler, Matusky & Skelly Engineers LLP	Public And Private Dredged Material Management Strategies In New Jersey: A Case Study Economic Analysis	2005	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Cost		Report (final, published)	Outside Study Area									X		
Leonard, L., Posey, M., Cahoon, L., Laws, R., and Alphin, T.	Sediment Recycling: Marsh Renourishment Through Dredged Material Disposal	2002	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Methods-Environmental	Marshes	Report (final, published)	Outside Study Area		X									
Linkov, I., Satterstrom, F. K., Kiker, G., Seager, T. P., Bridges, T., Gardner, K. H., Rogers, S. H., Belluck, D. A., and Meyer, A.	Multicriteria Decision Analysis: A Comprehensive Decision Approach For Management Of Contaminated Sediments	2006	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Journal Paper	N/A									X		

Authors	Title	Year of Publication	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Linkov, I., Satterstrom, F.K., Kiker, G., Batchelor, C., Bridges, T., and Ferguson, E.	From Comparative Risk Assessment To Multi-Criteria Decision Analysis And Adaptive Management: Recent Developments And Applications	2006	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Journal Paper	Outside Study Area									X		
Linkov, I., Satterstrom, F.K., Yatsalo, B., Tkachuk, A., Kiker, G.A., Kim, J., Bridges, T.S., Seager, T. P., and Gardner, K. H.	Comparative Assessment Of Several Multi-Criteria Decision Analysis Tools For Management Of Contaminated Sediments	2007	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Book	Outside Study Area									X		
Maher, A., Bennert, T., Jafari, F., Douglas, W.S., and Gucunski, N.	Geotechnical Properties of Stabilized Dredged Material (SDM) From The New York/New Jersey Harbor	2004	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Conference Proceedings	Outside Study Area			X								
Maher, A., Douglas, W.S., and Jafari, F.	Field Placement And Evaluation of Stabilized Dredged Material (SDM) From The New York/New Jersey Harbor	2006	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Journal Paper	Outside Study Area		X									
McMullen, K.Y., Poppe, L.J., Paskevich, V.F., Doran, E.F., Moser, M.S., Christman, E.B., and Beaver, A.L.	Surficial Geologic Interpretation And Sidescan Sonar Imagery Of The Sea Floor In West-Central Long Island Sound	2005	Sediment		Bottom Morphology	Physical Characteristics	Report (final, published)	Central LIS		X									
McMullen, K.Y., Poppe, L.J., Schattgen, P.T., and Doran, E.F.	Enhanced Sidescan-Sonar Imagery, North-Central Long Island Sound	2008	Sediment		Bottom Morphology	Physical Characteristics	Report (final, published)	Central LIS		X									
Miller, D.C.,	Detrimental Effects Of Sedimentation On Marine Benthos: What Can Be Learned From Natural Processes And Rates?	2002	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Journal Paper	Outside Study Area		X									
Munns, W.R., Berry, W.J., and Dewitt, T.H.	Toxicity Testing, Risk Assessment, And Options For Dredged Material Management	2002	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Journal Paper	N/A									X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Myers, T. E., Bowman, D.W., and Myers, K. F.	Dredged Material Composting at Milwaukee And Green Bay, WI, Confined Disposal Facilities	2003	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Report (final, published)	Outside Study Area		X									
Myre, P.L. and Germano, J.D.	Field Verification Program (FVP) Disposal Mound Monitoring Survey 2005.	2007	Benthic (Macro-Invertebrate) Resource	Sediment	All (Sediment)		Report (final, published)	Central LIS					X						
NOAA Coastal Services Center	Dredging And Disposal Of Marine Sediments: Regulations And Guidelines		State Dredged Material Disposal Guidance		All (State Guidance)		Website	N/A										X	
Poppe, L.J., Ackerman, S.D., Doran, E.F., Beaver, A.J., Crocker, J.M., and Schattgen, P.T.	Interpolation Of Reconnaissance Multibeam Bathymetry From North-Central Long Island Sound	2006	Sediment		Bottom Morphology		Report (final, published)	Central LIS		X									
Poppe, L.J., Ackerman, S.D., Doran, E.F., Moser, M.S., Stewart, H.F., Forfinski, N.A., Gardner, U.L., and Keene, J.A.	Geologic Interpretation And Multibeam Bathymetry Of The Sea Floor In Southeastern Long Island Sound	2006	Sediment		Bottom Morphology		Report (final, published)	Central LIS		X									
Poppe, L.J., Ackerman, S.D., McMullen, K.Y., Schattgen, P.T., Schaer, J.D., and Doran, E.F.	Interpolation Of Reconnaissance Multibeam And Single-Beam Bathymetry, Offshore Milford, Connecticut	2008	Sediment		Bottom Morphology		Report (final, published)	Central LIS		X									
Poppe, L.J., Knebel, H.J., Lewis, R.S., and DiGiacomo-Cohen, M.L.	Processes Controlling The Remobilization Of Surficial Sediment And Formation Of Sedimentary Furrows In North-Central Long Island Sound	2002	Physical Oceanographic		Sediment Transport		Journal Paper	Central LIS		X									
Poppe, L.J., McMullen, K.Y., Williams, S.J., Crocker, J.M. and Doran, E.F.	Estuarine Sediment Transport By Gravity-Driven Movement Of The Nepheloid Layer, Long Island Sound	2008	Physical Oceanographic	Sediment	Sediment Transport	Bottom Morphology	Journal Paper	Central LIS		X									

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Poppe, L.J., Paskevich, V.F., Moser, M.S., DiGiacomo-Cohen, M.L., and Christman, E.B.	Sidescan Sonar Imagery And Surficial Geologic Interpretation Of The Sea Floor Off Branford, Connecticut	2004	Sediment		Bottom Morphology	Physical Characteristics	Report (final, published)	Central LIS		X									
Price, R.A.	Beneficial Uses Of Dredged Material: Testing And Evaluating Dredged Material For Beneficial Use Suitability	2005	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Conference Proceedings	Outside Study Area											Forum for current research
Reed, D.J.	Dredged Materials And Environmental Restoration: A Win-Win Story?	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental	Testing and Evaluation-Cost	Abstract	Outside Study Area									X		
Rhoades, J.M., Yozzo, D.J., Cianciola, M.M., and Will, R.J.	Norton Basin/Little Bay Restoration Project: Historical And Environmental Background Report	2001	Environmental Evaluation and Economics of Disposal Options		Alternative Sites-Environmental		Report (final, published)	Outside Study Area	X										
Rozsa, Yamalis, Holst, and Young	Rates Of Tidal Wetland Loss	2002	Ecology, Habitats and Species		Marshes		Planned/Future	Western LIS	X										
Schroeder, P. R., and Aziz, N. M.	Effects Of Confined Disposal Facility And Vadose Zone Characteristics On Leachate Quality	2003	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Report (final, published)	N/A				X							
Schroeder, P. R., Palermo, M. R., Myers, T. E., and Lloyd, C. M.	The Automated Dredging And Disposal Alternatives Modeling System (ADDAMS)	2004	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Report (final, published)	N/A				X							
Shisler, J.K., and Szuch, R.P.	Wetland Development With Dredged Material	2005	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Methods-Environmental	Marshes	Conference Proceedings	Outside Study Area									X		
Simenstad, C., Cagney, P., and Barton, J.	Past And Potential Role Of Dredge Materials In Wetlands Creation And Restoration In The Pacific Northwest	2000	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Conference Proceedings	Outside Study Area									X		

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Smith, E. R., and Gailani, J. Z.	Nearshore Placed Mound Physical Model Experiment	2005	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Report (final, published)	N/A				X							
Stern, E.A., Lodge, J., Jones, K.W., Clesceri, N.L., Feng, H., and Douglas, W.S.	Decontamination And Beneficial Use Of Dredged Materials	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Conference Proceedings	Outside Study Area											Forum for current research
Streever, W.J., Patin, T.R., and Davis, J.E.	Creating And Restoring Wetlands With Dredged Material: A Summary Of Approaches And Issues	2000	Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Abstract	Outside Study Area									X		
Sweeney, A. and Sanudo-Wilhelmy, S.A.	Dissolved Metal Contamination In The East River–Long Island Sound System: Potential Biological E?ects	2004	Water Quality		All (Water Quality)		Journal Paper	Western LIS		X									
Tiner, R.W., Huber, I.J., Nuerminger, T., and Marshall, E.	Salt Marsh Trends In Selected Estuaries Of Southwestern Connecticut	2006			Marshes		Report (final, published)	Western LIS	X										
U.S. Army Corps of Engineers - New York District	Dredged Material Management Plan For The Port Of New York And New Jersey: 2008 Update, Volume I	2008	State Dredged Material Disposal Guidance	Environmental Evaluation and Economics of Disposal Options	All (Environmental and Economics)	New York	Report (final, published)	Outside Study Area										X	
U.S. Army Corps of Engineers	Evaluation Of Dredged Material Proposed For Disposal At Island, Nearshore, Or Upland Confined Disposal Facilities - Testing Manual	2003	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Report (final, published)	N/A										X	
U.S. Environmental Protection Agency - Office of Superfund Remediation and Technology Innovation	The Use Of Soil Amendments For Remediation, Revitalization And Reuse	2007	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental	Land Use	Report (final, published)	N/A										X	

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
U.S. Environmental Protection Agency - Office of Wetlands, Oceans, & Watersheds	Beneficial Uses Of Dredged Material	2007	Environmental Evaluation and Economics of Disposal Options	Coastal Management	All (Environmental and Economics)		Website	N/A									X		
U.S. Environmental Protection Agency and U.S. Army Corps of Engineers	Beneficial Uses Of Dredged Material	2006	Environmental Evaluation and Economics of Disposal Options		Alternative Methods-Environmental		Website	N/A										X	
U.S. Environmental Protection Agency and U.S. Army Corps of Engineers	Evaluating Environmental Effects Of Dredged Material Management Alternatives - A Technical Framework	2004	Environmental Evaluation and Economics of Disposal Options	State Dredged Material Disposal Guidance	All (Environmental and Economics)	All (State Guidance)	Report (final, published)	N/A										X	
U.S.Army Corps of Engineers, New York District	Draft Integrated Ecosystem Restoration Report/Environmental Assessment Spring Creek, Brooklyn, New York		Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Report (draft)	Outside Study Area	X										
U.S.Army Corps of Engineers, New York District	Initial Appraisal Report Beneficial Uses Of Dredged Material For Aquatic Ecosystem Restoration At Norton Basin And Little Bay		Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Report (draft)	Outside Study Area	X										
U.S.Army Corps of Engineers, New York District	Integrated Ecosystem Restoration Report/Environmental Assessment Marine Park, Brooklyn, New York		Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Report (final, published)	Outside Study Area	X										
U.S.Army Corps of Engineers, New York District	Jamaica Bay Marsh Islands, Jamaica Bay, New York Integrated Ecosystem Restoration Report Environmental Assessment And Finding Of No Significant Impact	2005	Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Report (final, published)	Outside Study Area	X										

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
U.S.Army Corps of Engineers, New York District	Jamaica Bay, Marine Park And Plumb Beach, New York Environmental Restoration Project Draft Interim Feasibility Report Kings And Queens Counties, New York	2010	Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Report (draft)	Outside Study Area	X										
US Army Corps of Engineers - Seattle District	Feasibility Phase Final Report - Puget Sound Confined Disposal Site Study, Washington	2003	Environmental Evaluation and Economics of Disposal Options		All (Environmental and Economics)		Report (final, published)	Outside Study Area	X										
Valente, R.M.	Response Of Benthic Infauna And Epifauna To Ocean Disposal Of Red Clay Dredged Material In The New York Bight: A Study Using Sediment-Profile Imaging, Surface Imaging And Traditional Methods	2006	Environmental Evaluation and Economics of Disposal Options	Benthic (Macro-Invertebrate) Resource	Testing and Evaluation-Environmental		Journal Paper	Outside Study Area					X						
Varney, R.W.	Islander East Pipeline Project Final Environmental Impact Statement	2002	General Interest				Abstract	Central LIS	X										
Wahle, R.A., Dunnington, M., O'Donnell, K., and Bell, M.	Impact Of Dredged Sediment Disposal On Lobster And Crab Abundance And Movements At The Rockland Disposal Site	2004	Environmental Evaluation and Economics of Disposal Options	Fisheries/ Shell Fisheries	Testing and Evaluation-Environmental	Lobster	Report (final, published)	Outside Study Area		X									
Wakeman, T.H.	The Difficulties Of Dredging And Placement For Beneficial Use Projects	2000	Environmental Evaluation and Economics of Disposal Options		Alternative Sites-Environmental		Abstract	Outside Study Area									X		
Walter, P.J., Andrews, B., and Myre, P.L.	Evaluating Dredged Material In A Sub-Channel Confined Aquatic Disposal Environment: Experience From The Boston Harbor Navigation Improvement Project	2000	Environmental Evaluation and Economics of Disposal Options	Sediment	Testing and Evaluation-Environmental	Physical Charac-teristics	Conference Proceedings	Outside Study Area		X									

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Wang, Y.H.	The Intertidal Erosion Rate Of Cohesive Sediment: A Case Study From Long Island Sound	2003	Physical Oceanographic	Geology and Geomor-phology	Sediment Transport	All (Geology)	Journal Paper	Central LIS				X							
Weinstein, M.P., and Weishar, L.L.	Beneficial Use Of Dredged Material To Enhance The Restoration Trajectories Of Formerly Diked Lands	2002	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Alternative Sites-Environmental	Marshes	Journal Paper	Outside Study Area											Data compa-rison
Wells, B., and Norfleet, T.	The Role Of The U.S. Army Corps Of Engineers In Brownfield Redevelopment	2003	Coastal Management		Land Use		Report (final, published)	Western LIS									X		
Welp, T.L., Clausner, J.E., Thompson, D., Mujica, J., and Boddie, G.	Demonstration Project On Dredging And Marsh Development Using A Flexible-Discharge Dustpan Dredge At Head Of Passes/Southwest Pass Mississippi River	2004	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Report (final, published)	Outside Study Area		X									
Wenning, R.J. and Woltering, D.M.	Use Of Ecological Risk Assessment Methods To Evaluate Dredged Material Management Options	2000	Environmental Evaluation and Economics of Disposal Options		Testing and Evaluation-Environmental		Abstract	Outside Study Area									X		
White, P., Pimentel, E., and Pound, M.	Contaminated Sediment Management Options In San Francisco Bay	2000	Environmental Evaluation and Economics of Disposal Options		Alternative Sites-Environmental		Conference Proceedings	Outside Study Area									X		
Williams, P.B.	The Experience Of Tidal Wetland Restoration Using Dredged Materials In San Francisco Bay - Its Implications For Future Restoration Planning	2000	Historic Disposal Activities and Dump Sites	Ecology, Habitats and Species	Biological Effects	Marshes	Abstract	Outside Study Area									X		
Wilson, R.E., Flagg, C.N., Codiga, D.L., and Waliser, D.E.	Sound Science: Research In Real Time		Water Quality		All (Water Quality)		Database (published)	Western LIS					X						

ED_001437D_00000426-00175

Authors	Title	Year of Publica-tion	Primary Topic 1	Primary Topic 2	Subtopic 1	Subtopic 2	Document Type	Other Geographic Area	Environmental Analysis	Field Sampling	Lab Analysis/Tests	Model	Monitoring	Baseline	Impacts Analysis	Historical	Review	Regulations/Manuals	Other/Unspecified
Zimmerman, R. and Rozas, L.	Design Planning For Salt Marshes Created From Dredged Materials: A Case Study In Galveston Bay, Texas	2000	Environmental Evaluation and Economics of Disposal Options	Ecology, Habitats and Species	Testing and Evaluation-Environmental	Marshes	Abstract	Outside Study Area		X									

Appendix C

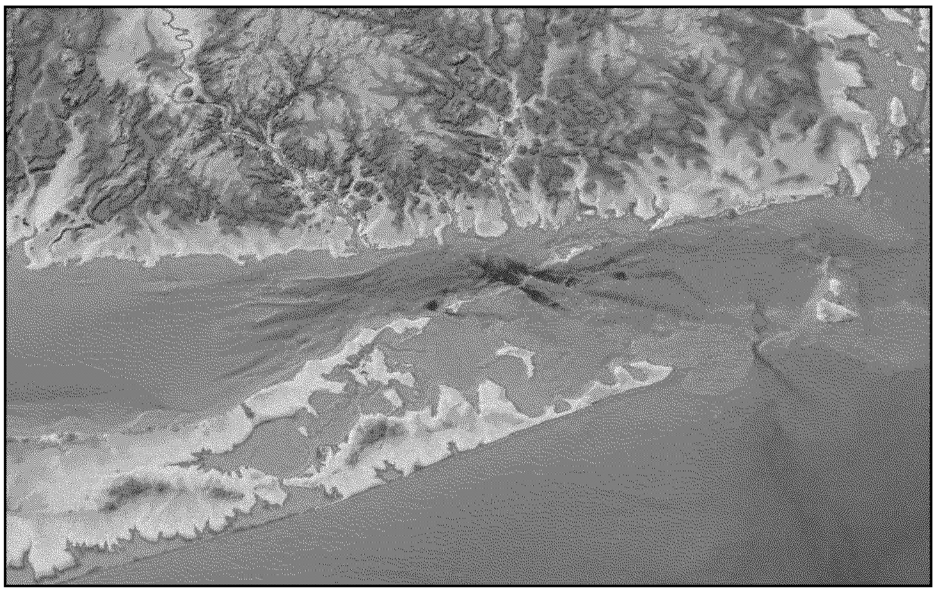
Physical Oceanography of Eastern Long Island Sound: Literature Review

Prepared by University of Connecticut

[This page intentionally left blank.]

Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Eastern Long Island Sound, Connecticut and New York

Physical Oceanography of Eastern Long Island Sound: Literature Review



Prepared for: **United States Environmental Protection Agency**

Sponsored by: **Connecticut Department of Transportation**

Prepared by: **University of Connecticut**

UCONN

October 2013

ED_001437D_00000426-00179

[This page intentionally left blank.]

Supplemental Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Eastern Long Island Sound, Connecticut and New York

PHYSICAL OCEANOGRAPHY OF EASTERN LONG ISLAND SOUND: LITERATURE REVIEW

Prepared for:

United States Environmental Protection Agency
5 Post Office Square, Suite 100
Boston, MA 02109

Sponsored by:

Connecticut Department of Transportation
Waterways Administration
2800 Berlin Turnpike
Newington, CT 06131-7546

Prepared by:

James O'Donnell
University of Connecticut
Department of Marine Sciences
1080 Shennecossett Road
Groton, CT 06340

October 16, 2013

[This page intentionally left blank.]

Table of Contents

EXECUTIVE SUMMARY

This report reviews the existing literature on the physical oceanography of the Zone of Siting Feasibility (ZSF) for designation of disposal sites for dredged material. The review process started with the previous reports developed for the Long Island Sound Dredged Material Management Plan (DMMP). References therein was augmented by references developed for a review article on the Physical Oceanography of Long Island Sound completed by a group of ten leading experts on the subject brought together by the USEPA Long Island Sound Study. The reports of the Rhode Island Sound Special Area Management plan process complemented this work with an extensive description of the Physical Oceanography of Block Island Sound.

The primary variables that are important to the management of dredged material disposal sites are the bottom stress and the circulation (currents). These variables determine whether the material deposited will be stable on the bottom and what areas are may be impacted by disposal operations. To compare various areas in the ZSF for their suitability as a site for the disposal of dredged material, a numerical model is essential.

The pattern and magnitudes of bottom stress and currents in estuaries are largely controlled by tides, winds, waves and river discharge. The review demonstrates that the tidal forcing is well characterized. Further, we show that the river discharges, winds, currents, and waves in the ZSF have a substantial seasonal cycle. The river discharge is high in the spring (March -May), and winds and waves are largest in the winter (December -February). We find that the available data do not adequately characterize the spatial structure and time variability of the circulation and wave field parameters. Further, there are no direct measurements of bottom stress in the ZSF.

A field study is necessary to provide measurements that will assess the veracity of the model used in the site designation process at a dynamically diverse set of locations. Particular emphasis should be placed on the acquisition of direct measurements of the waves and bottom stress in conditions that represent the range normally expected in the regions. This should include periods of (1) high river discharge and high winds and waves, (2) low river discharge and low winds and waves, and (3) low discharge and high wind and waves.

ED_001437D_00000426-00184

1. INTRODUCTION

In 2005, the United States Environmental Protection Agency (USEPA) designated the Western and Central Long Island Sound (WLIS/CLIS) dredged material disposal sites, following the preparation of an EIS (USEPA, 2004). The two disposal sites in the Eastern Long Island Sound (ELIS), Cornfield Shoals Disposal Site (CSDS) and New London Disposal Site (NLDS), are scheduled to close in December 2016 (Figure 1). The USEPA plans to prepare a Supplemental EIS (SEIS) for the potential designation of one or more disposal sites needed to serve the ELIS region, since the anticipated dredged material disposal needs of the surrounding communities cannot be met by the combined capacity of all available “not-in-water” disposal alternatives. The ZSF consists of the ELIS and Block Island Sound (BIS; Figure 1). Aside from the two active dredged material disposal sites (NLDS and CSDS), there are several sites that were historically used for dredged material disposal and these are also shown in Figure 1.

To support the development of a SEIS for potential dredged material disposal site(s), the USEPA requested a study of the physical oceanography within the ZSF. The study includes the following tasks:

- Literature search for available data pertinent to the physical oceanographic conditions in the ZSF (this document). This review considered documents summarized for the DMMP for the Long Island Sound (LIS) region (WHG, 2010), as well as other key recent documents and data sources relevant for the understanding of the physical oceanography in the ZSF (see Attachment A).

- Physical Oceanography (PO) field study to fill data gaps identified via the literature search. The field study is described in the Quality Assurance Project Plan (QAPP) for Physical Oceanography Data Collection in Eastern Long Island Sound (UConn and Louis Berger, 2013).

- Numerical modeling to assess the potential for bottom sediment erosion and to identify likely sediment transport pathways at potential dredged material disposal sites. As described in Attachment 5 to the PO Study QAPP, the numerical modeling effort will make use of the Finite Volume Coastal Ocean Model (FVCOM; Chen et al., 2007) and the United States Army Corps of Engineers' (USACE) Short Term Fate (STFATE) and Long Term Fate (LTFATE) models. The suite of models will be calibrated and validated using data gathered through the literature search and collected during the PO field study. The models will be used to simulate of PO characteristics at potential sites where observations are not available and also to simulate the effects of extreme events (e.g., large storms).

ED_001437D_00000426-00185

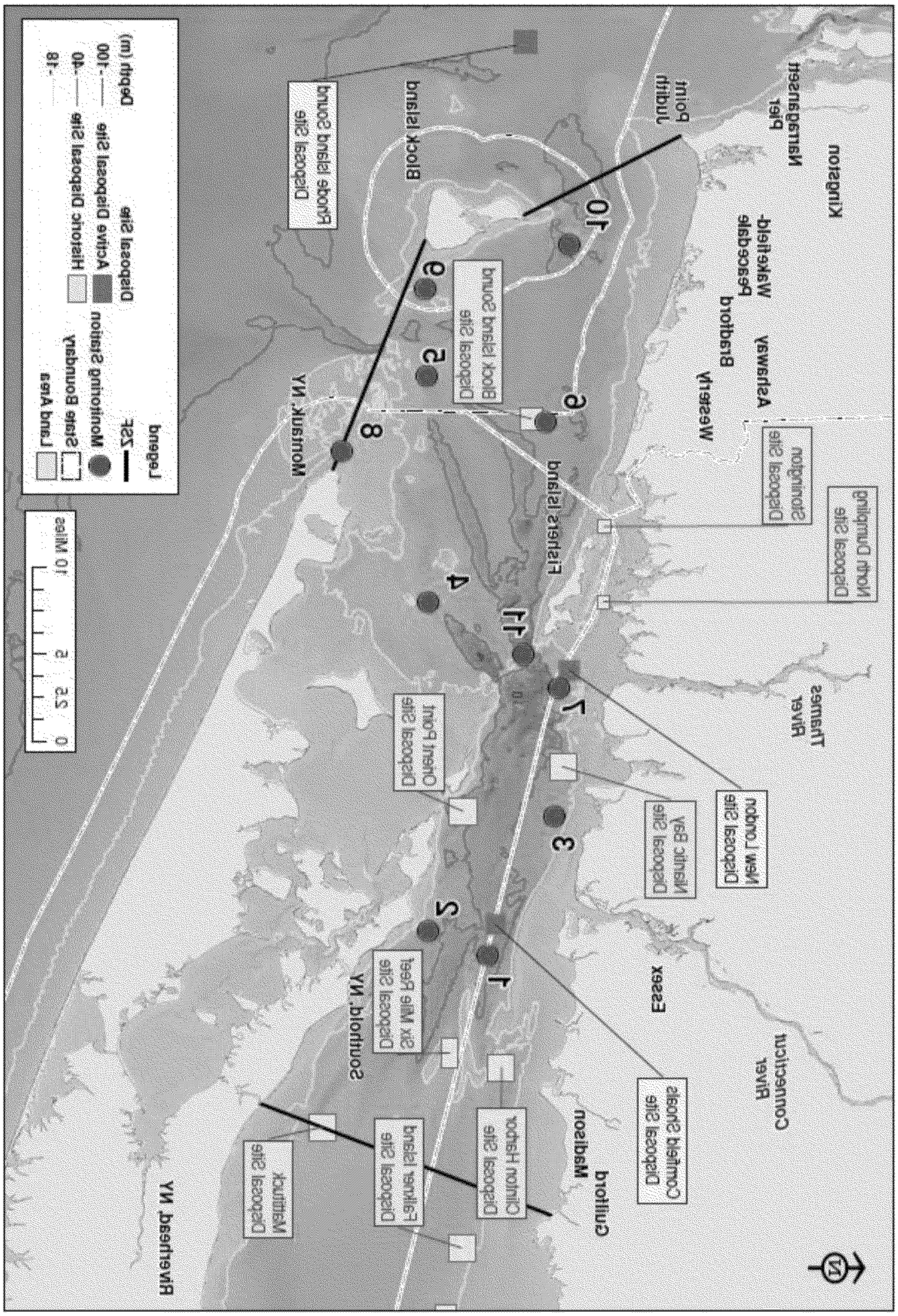


Figure 1. Zone of Siting Feasibility , consisting of Eastern Long Island Sound and Block Island Sound (black lines). Marked are also active and historic dredged material disposal sites and locations of PO field study monitoring stations. Seven of these stations (Stations 1 to 7) have instrument moorings.

ED_001437D_00000426-00186

An extensive review of the state of the science of sediment transport in the coastal ocean and estuaries has been presented by Winterwerp and van Kesteren (2004). Many mathematical models have been developed and used to design disposal projects and predict impacts. The fundamental physics of the models are essentially the same and it is clear that the transport and fate of suspended matter from dredged material disposed at open-water disposal sites (such as NLDS and CSDS) is dominantly controlled by water circulation patterns and wave conditions. These characteristics are termed the Physical Oceanography of an area; they jointly determine the movement of water, the bottom stress, and the potential for sediment erosion (resuspension) and deposition. Currents and bottom stress are mainly due to the effect of the tidal forces on the ocean and are, therefore, periodic. However, during storms waves and currents can have a very significant effect on current and stress magnitudes and patterns.

The ELIS site selection process will consider potentially suitable locations within the ZSF (Figure 1) and so the currents, waves and bottom stress conditions must be estimated using a numerical model that has been shown to be consistent with observations at a range of locations for a wide range of weather conditions. Because of the sensitivity to weather, current magnitudes and wave parameters in the ELIS and BIS vary seasonally. There are also substantial inter-annual variations, i.e., some years have more intense storms than others. In addition, the delivery of freshwater to the ELIS in the spring largely determines the pattern of the salinity and dominates the variability in long-term (several days) transport of suspended solids and the areas potentially impacted by disposal operations and resuspension. Large storm events (e.g., hurricanes) in the watershed also change the circulation and the suspended sediment distribution in the LIS. Characterizing the likely effects of hurricanes must rely on simulation since it is unlikely that a limited duration field program will capture rare events. Careful assessment of the simulations during more frequent storms will build confidence in the predictions.

In this literature review, we identified and summarized the available data for waves, circulation and bottom stress in the ZSF for the purpose of site selection and, in particular, for evaluation of the model. We also reviewed the availability of measurements of the variables that are essential to predicting the spatial structure and time variations in currents and bottom stress (i.e., wind speed and direction, sea level, river discharge, solar radiation, temperature, and salinity). Data gaps critical to the numerical modeling and SEIS preparation were also identified, and recommendations for addressing the data gaps were made (including the PO field data collection). In summary, and as stated in the Data Quality Objectives included in the QAPP, the goals of the data review and collection effort were to:

- Characterize the relationships between salinity, river discharge and precipitation, temperature distribution, wind stress magnitude, and the long-term transport of sediment in the ZSF.
- Characterize the influence of current structure, sea level fluctuation, and wave parameters on bottom stress and sediment fate and transport in the ZSF.
- Obtain necessary input data for the FVCOM model of circulation and hydrography in the ZSF to generate distributions of tidal currents and bottom stress.

2. AVAILABLE OBSERVATIONS

Relevant available PO observations in the ZSF prior to 2000 were summarized by ENSR (2001) as part of the WLIS/CLIS EIS process. The WLIS/CLIS EIS (USEPA, 2004) also reviewed observations in ELIS but was primarily focused on data collection in the western and central portions of LIS. This ELIS SEIS builds on those reviews for information on the eastern portion of the LIS. Other major sources of information are: the detailed review of the physical oceanography of LIS by O'Donnell et al. (2014), and the summary of the characteristics of Rhode Island waters developed as part of the Rhode Island Special Area Management Plan (SAMP) process described by Codiga and Ullman (2011a). The 127 reports and research papers identified by O'Donnell et al. (2014) and the 91 documents cited by Codiga and Ullman (2011a) were also assessed for relevance to the ELIS SEIS physical oceanography study. A comprehensive list of the relevant documents identified is provided in Attachment A.

2.1 Bottom Stress Observations

When the stress (τ_b) applied to the ocean bottom by waves and currents exceeds a critical value (the critical shear stress [τ_c], which is determined by the characteristic size and density of the particles on the bottom), sediment can become suspended (Raudkivi, 1967). Once that occurs, the particles tend to move with the flow until the bottom stress drops below τ_c.

There are only few existing, direct observations of bottom stress in the ZSF. The earliest measurements were reported by Ianniello (1979) at the New London Disposal Site; however, available technology limited the data collection period to four days. Wang et al. (2000) presented estimates of the stress based on 15 days of wave and current measurements in the central LIS; however, these estimates were based on the quadratic drag-law assumption and the Grant and Madsen (1979) model for wave current interaction. Several model studies have developed estimates of the bottom stress distributions (e.g., Signell et al., 2000), although none have reported measurements.

Since there are no bottom stress data that are adequate to fulfill the Data Quality Objectives for this SEIS, the PO field study includes the deployment of seven moorings in the ZSF with downward directed high-resolution, pulse-coherent, near-bottom acoustic current meters to measure the ocean current between 0.25 and 1.5 m above the seafloor, so that the bottom stress can be estimated (details are described in the QAPP). The subsequent FVCOM modeling effort will predict bottom stress based on input data representing current, wind, and wave characteristics in the ZSF. The model-predicted bottom stress vector components will be compared to the data collected during the PO field study to validate the model output and calibrate the model, as necessary.

2.2 Current Measurements

The currents in the ZSF are directly related to bottom stress that will determine the magnitude of sediment resuspension and also to the subsequent transport of resuspended sediments away from potential disposal sites. FVCOM will predict both tidal currents and changes in currents during periods of strong wind forcing. The STFATE model will use the circulation predicted by FVCOM as input data to predict the dispersion of dredged material during the first few hours

ED_001437D_00000426-00188

after the material is released into the water column from a barge or scow. Predictions of near-bottom currents from FVCOM will also be used as input to the LTFATE model, which will subsequently predict resuspension and transport of sediments from potential mounds created by dredged material disposed at potential sites.

Vieira (2000) reported a summary of an extensive study with current meter deployments throughout Long Island Sound. He used single-level mechanical current meters and deployed them for approximately one month on several north-south sections across the LIS. The locations are shown in Figure 2. Only two cross-sections with six current meters were in the ZSF and these were occupied in June and September, 1988. In addition to the spatial limitations, the utility of these data is limited due to their discrete-depth measurement, since validation of the FVCOM predictions will require characterization of the vertical structure of currents in the ZSF.

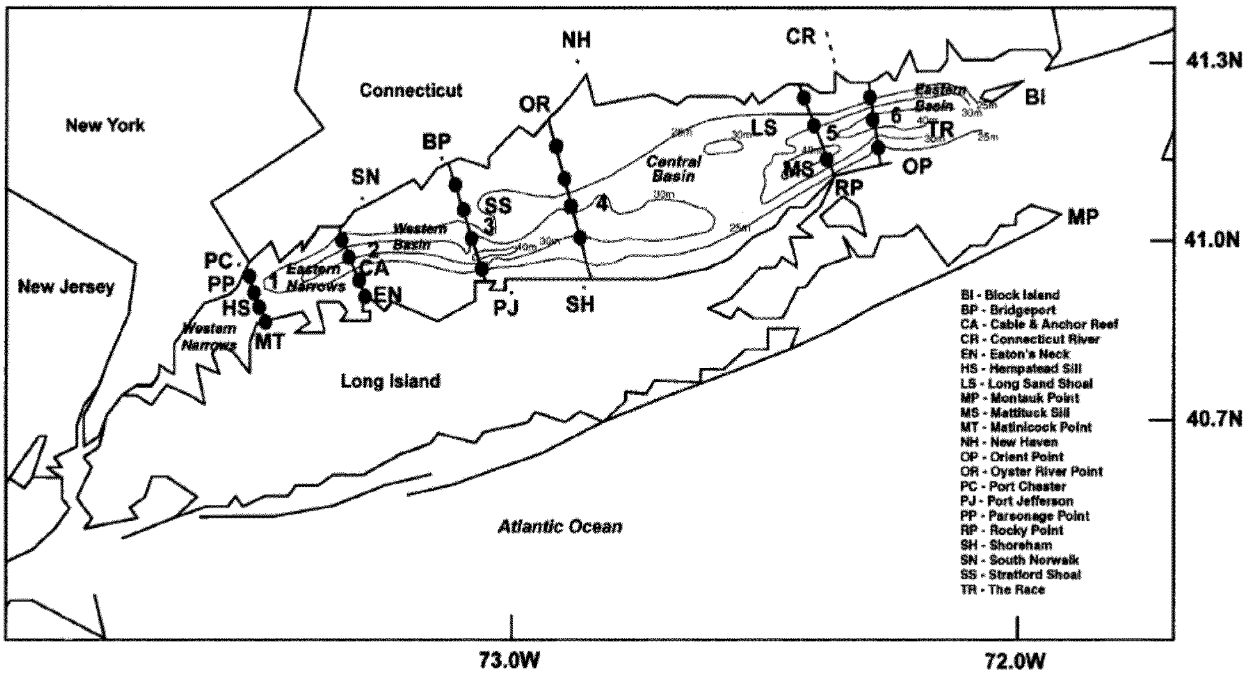


Figure 2. Location of moorings used in the study by Vieira (2000).

The development of Acoustic Doppler Current Profilers (ADCPs) in the late 1980's allowed the vertical structure of the horizontal velocity components in the coastal ocean to be resolved. The first deployments of bottom-mounted ADCPs in LIS were reported by Earwacker (1990). This program, and the subsequent measurement campaign with older single-level current meters that was described by Vieira (2000), cycled instruments around sites in LIS; however, this sampling approach did not capture any seasonal variation in the mean circulation pattern in the LIS. Another ADCP program in LIS and BIS was performed in 2010 and the data are available at NOAA (2010). Station locations varied seasonally (Figure 3); the available current profile data are concentrated in BIS in the spring and winter, and in LIS in the summer and fall. Clearly, the available current data in the ZSF are inadequate for the purposes of detecting the seasonal pattern of circulation.

Additional ADCP deployments in the region were reported by Bennett et al. (2010), Codiga and Rear (2004), and Codiga and Ullman (2011b). Because the deployment stations were outside of the ZSF boundaries, these data may prove useful for the model assessment but are not sufficient to validate the model predictions in the ZSF.

Current profile data from ship -mounted ADCP surveys were reported by O'Donnell and Bohlen (2003) along a section between Hammonassett Point, CT, and Mattituck, NY . The surveys were conducted for 10 days in the spring o f 1995. Figure 4a shows the locations and an example of the observed mean near -surface and near -bottom flows . Codiga and Aurin (2006) described

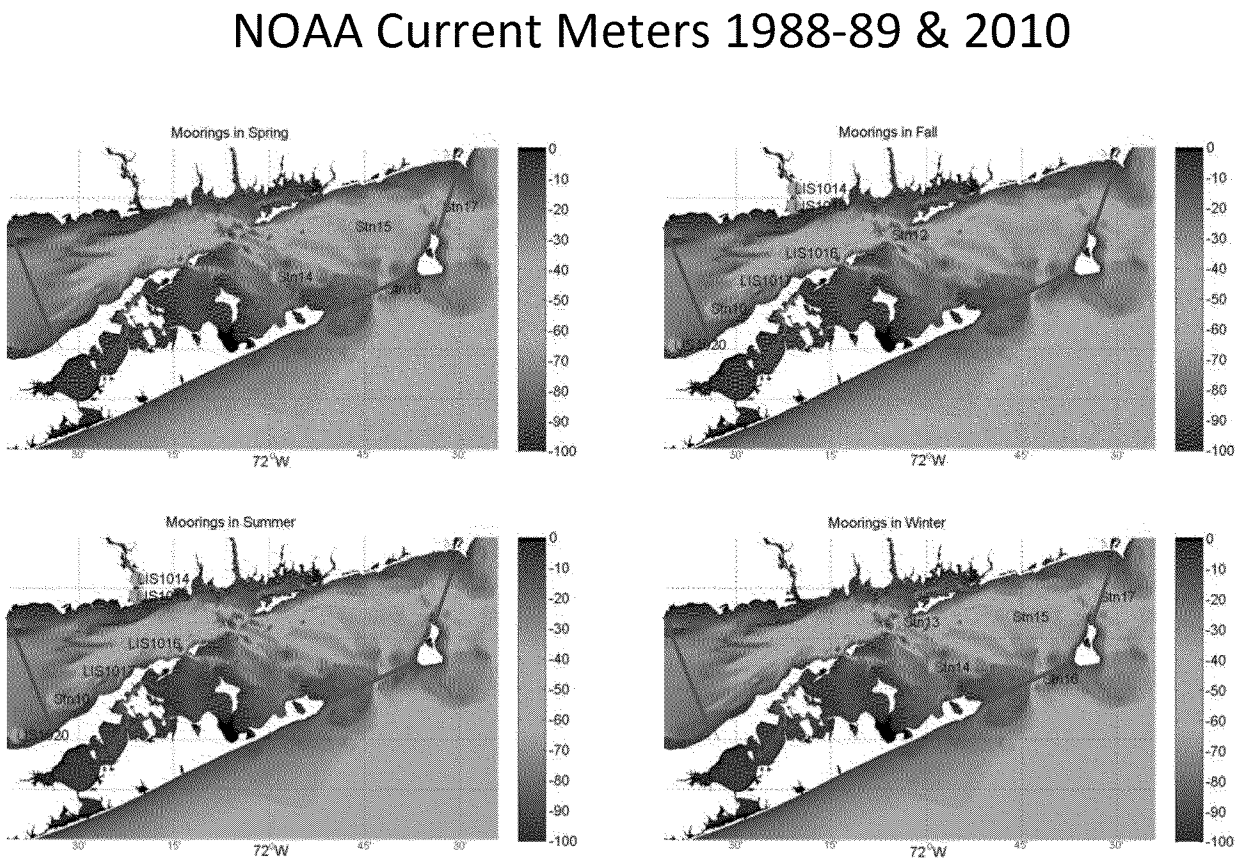


Figure 3. Distribution of ADCP station location (magenta circles) in the ZSF (green lines) occupied in the Earwacker (1990) and the NOAA (2010) studies. The colors show water depth in m.

ED_001437D_00000426-00190

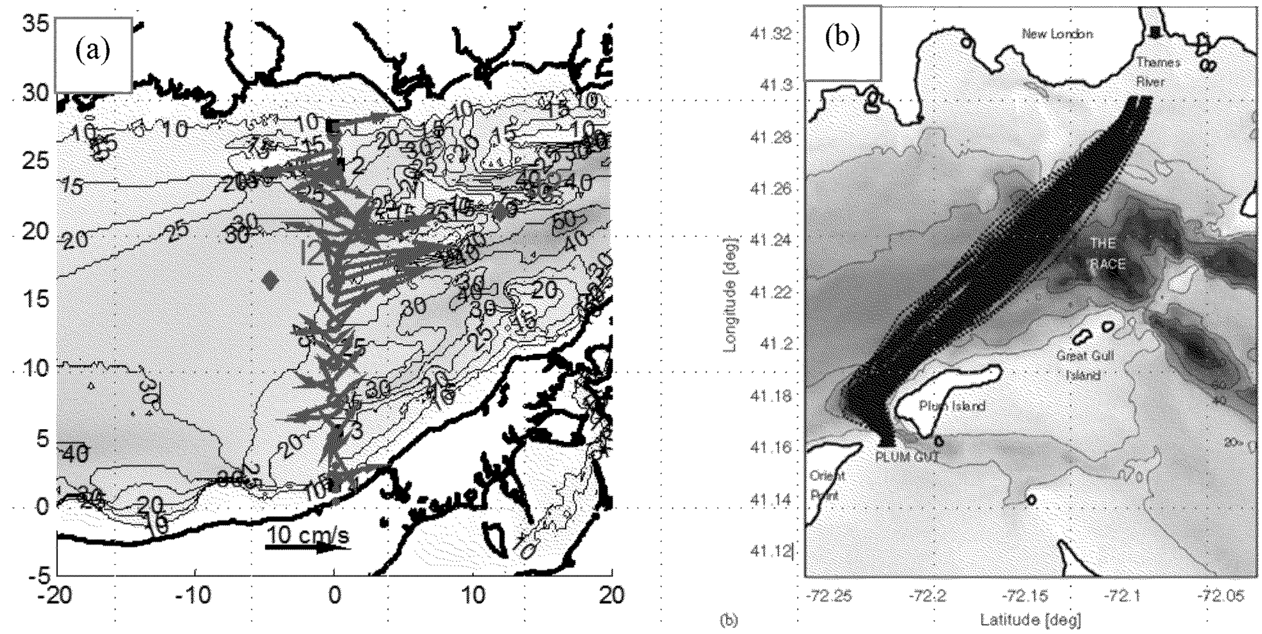


Figure 4. (a) The location of the observations of O'Donnell and Bohlen (2003) together with the mean near-surface current (red) and the mean near-bottom flow (blue); red diamonds indicate CTDEEP sampling stations 12 and 22; they are referred to earlier in the document and described by Kaputa and Olsen. (b) Location of the Codiga and Aurin (2006) data.

Surface current measurements (approximately within the upper meter of the water column) obtained by an HF RADAR array in the BIS have been available since 2000. The seasonal means and variability of the circulation measured by the HF RADAR array is described in Ullman and Codiga (2004). The spatial extent of the data set is shown in Figure 5 and coincides with the central and eastern portion of the ZSF. Surface currents have also been measured in this region for shorter times using Lagrangian drifters by O'Donnell and Allen (1992) and Ullman et al. (2006).

ED_001437D_00000426-00191

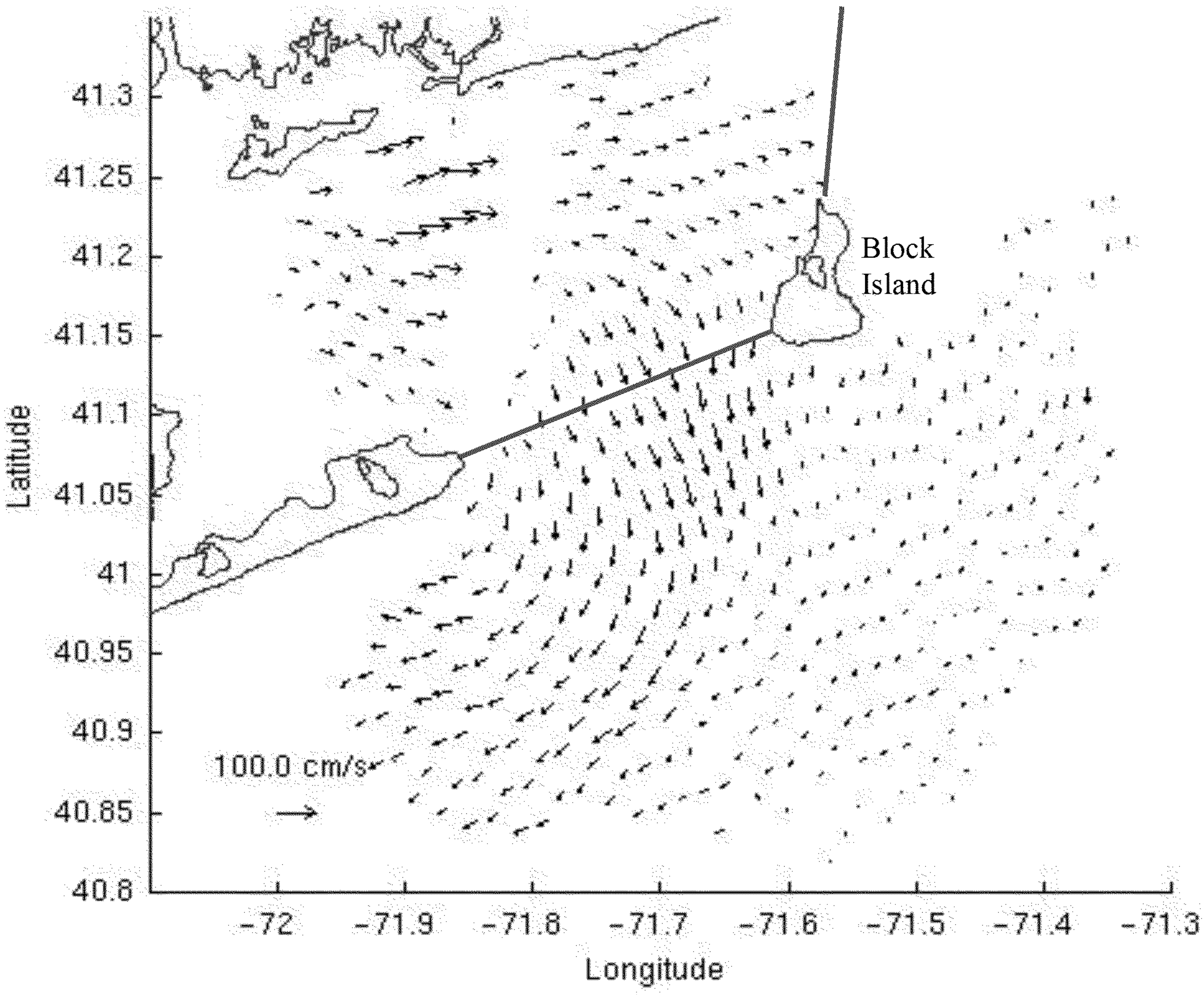


Figure 5. Example of surface current distribution observed by an HF RADAR array from November 9th, 2000. BIS is located in the northern half of the graphic, southern and eastern boundaries of the ZSF are shown by the green lines. (Source: http://nopp.dms.uconn.edu/CODAR/index.html).

While the existing data include surface current measurements and ADCP profiles in the ZSF, the spatial and temporal extent of the available data is insufficient to support model validation for the ELIS SEIS. To supplement the available current data, the PO field study includes deployment of seven moorings, each with an upward-looking ADCP to measure profiles of current and waves. In addition, vessel surveys are conducted three times during the mooring deployment periods. A hull-mounted ADCP will be used to measure current patterns during the vessel surveys. Data obtained during the PO field study, along with the available data described above, will be used for comparison to model predictions and to guide model calibration, as necessary. As stated above, data-gathering and modeling efforts are described in the QAPP for the PO field study.

2.3 Wave Measurements

The estimation of bottom stress requires measurements of wave amplitude and period. There are currently no empirical wave measurements available for the ZSF; however, there are two buoys near the boundaries that report wave height, periods, and direction. Specifically, Figure 6 shows the locations of the Long Island Sound Integrated Coastal Observation System (LISICOS), Central Long Island Sound (CLIS) buoy, and the USACE Coastal Data Information Program (CDIP) buoy. O'Donnell et al. (2014) summarized the characteristics of the CLIS observations and Grilli et al. (2011) described the observation in Rhode Island Sound, in an area to the east of the ZSF. Since these data records are close to the boundaries of the ZSF and record a much longer time window than can be expected in the planned field program, they will be valuable in the evaluation of the wave fields predicted by the model that is planned.

The ZSF wave characteristics will be modeled via FVCOM, including wind forcing. To obtain data for model validation and calibration, the ADCPs moored at seven locations in the ZSF include bottom pressure sensors to collect data on sea level and wave parameters, in addition to current structure. The data obtained during the PO field study will be compared to the FVCOM predictions of wave amplitude and wave period.

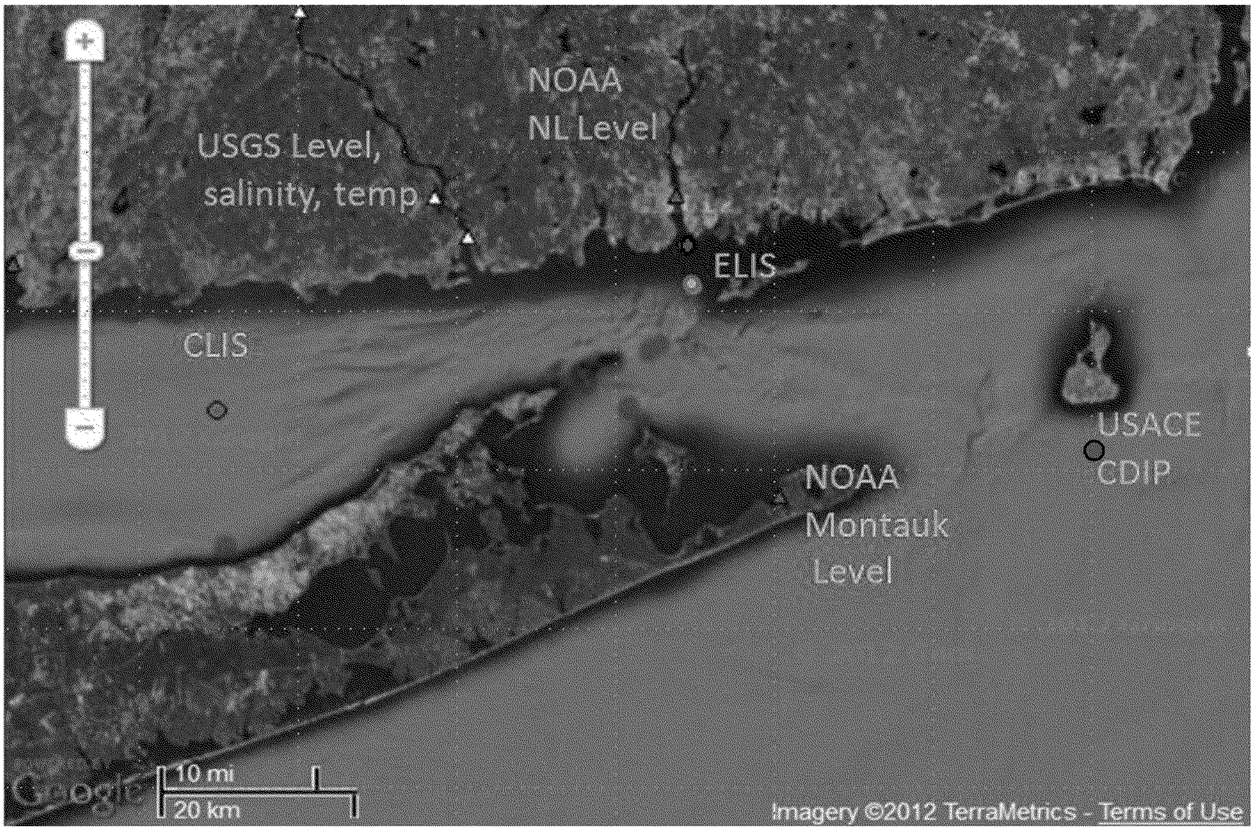


Figure 6. Map of ELIS and BIS showing the location of three buoys: CLIS (green circle), ELIS (yellow circle), and CDIP (red circle). The locations of NOAA water level measurements at New London (NL) and Montauk are also shown (green triangles). The white triangles show the locations of USGS water level, and salinity and temperature sensors. The red plus symbol shows the location of meteorological sensors at Ledge Light lighthouse.

2.4 Sea Level

The distribution of water depth is another factor that determines currents and shear stresses. Both the stability of bottom sediments and the fate of suspended material are largely controlled by the pattern and magnitude of the circulation. In LIS the circulation is mainly forced by tidal fluctuation of sea level on the New England continental shelf, but it is also influenced by the wind stress magnitude and direction (see Section 2.5 below) and by gradients in salinity and temperature (see Section 2.6 below). An extensive network of sea level sensors is operated by NOAA at two stations in the ZSF (New London, Montauk; Figure 6). The records from these stations extend over more than 30 years. Additional stations that may be useful for later modeling are at Newport, RI, and Quonset, RI. The existing sea level data from the two stations in the ZSF will be used to calibrate FVCOM. During the field study, the ADCPs moored at locations in the ZSF include bottom pressure sensors to collect data on sea level, which will be used to validate the FVCOM output.

2.5 Wind

Measurements of the wind speed and direction over the water are few. Wind is only measured within the ZSF at the CLIS and ELIS buoys (see Figure 6 for location). Other atmospheric variables are also measured. A summary of available data is presented in Table 1.

Wind and wave climatology data for the region will be gathered from UConn buoys both for the hydrodynamic and sediment transport models. These data will be analyzed to determine frequency and magnitude of storm events. Meteorological data (wind, air and water temperature, and relative humidity) will be collected at two sites in Long Island Sound: the ELIS buoy (located near the New London Disposal Site) and Ledge Light (near New London Harbor). UConn also maintains a directional wave buoy in the Central LIS.

Wind forcing data will be provided to the model as an input. In addition to the data described above, the 80-year wind record at Bridgeport, CT (Sikorsky Airport) will be used to assess the 10- and 100-year storm characteristics and to simulate extreme bottom stress magnitudes during the winter-spring period when Nor'easters dominate the meteorology. Hurricane force winds and their impact on sea level variations have been modeled using FVCOM and parametric representations of hurricane wind field evolution. Finally, the data from the LISICOS CLIS buoy will be used to validate the FVCOM predictions for that location.

Table 1. LISICOS BUOY Meteorology and Wave Data Availability (lisicos.uconn.edu)

Year	ELIS Meteorological Data	CLIS Meteorological Data	CLIS Waves
2012	(*)	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2011	(*)	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2010	WS,WD,AT,BP,RH	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2009	WS,WD,AT,BP,RH	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2008	WS,WD,AT,BP,RH	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2007	WS,WD,AT,BP,RH	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2006	WS,WD,AT,BP,RH	WS,WD,AT,BP,RH	ZX,HA,TZ,HM,HS,TS,H10,T10,TA,TP,TP5,HMO,MD,MS
2005	(*)	WS,WD,AT,BP,RH	HS,TA,TD
2004	(*)	WS,WD,AT,BP,RH	HS,TA,TD
2003	(*)	WS,WD,AT,BP,RH	HS,TA,TD
2002	(*)	WS,WD,AT,BP,RH	HS,TA,TD

WS-wind speed, WD-wind direction, AT-air temperature, BP-barometric pressure, RH-relative humidity
HS-significant wave height, TA-average period, TD-dominant period
ZX-zero crossings, HA-average wave height, TZ-mean spectral period, HM-maximum wave height
TS-significant wave period, H10-average height of highest 1/10th, T10-average period of wave in H10
TP-peak period, TP5-Peak wave period in seconds as computed by the READ method.
HMO-Wave amplitude using the water level variance, MD-mean wave direction, MS-mean spread
(*) No data due to funding limitations

2.6 Temperature and Salinity

The temperature and salinity distributions, and their temporal variability, in LIS and BIS are summarized by O'Donnell et al. (2014) and Codiga and Ullman (2011a); the available data sets are also described. In LIS, the largest archive was established by the Connecticut Department of Energy and Environmental Protection (CTDEEP) that has been surveying the entire LIS each month since 1991 and is continuing the monitoring program. It is described by Kaputa and Olsen (2000); data are described by Gay et al. (2004) and Gay and O'Donnell (2007). Figure 7a shows the station distribution. The stations are densest in the west where there is persistent seasonal hypoxia, and there are only three stations are within the ZSF. The across-Sound resolution of the CTDEEP surveys is low; this was addressed by O'Donnell and Bohlen (2003) and Bennett et al. (2010) who executed short-term high-resolution surveys along the sections shown in Figures 7b-d to refine the lateral structure of salinity, temperature, and the water density fields.

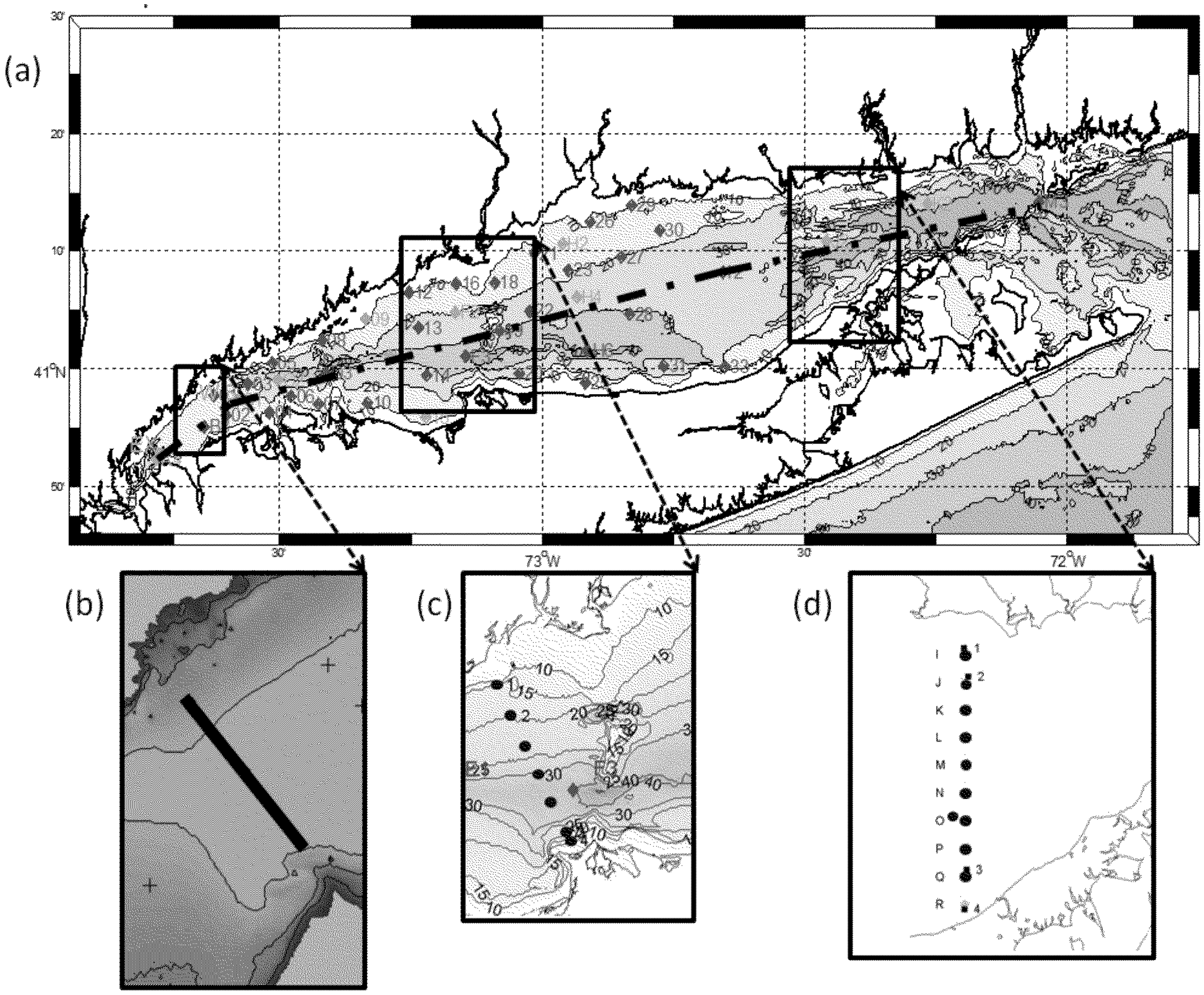


Figure 7. (a) Map of Long Island Sound showing the bathymetry (depths in m) and the locations of the CTDEEP hydrographic survey stations. (b) Coastline and cruise track used in the observation program is described by Bennett et al. (2010). (c) and (d) Stations used by O'Donnell and Bohlen (2003).

Codiga and Ullman (20 11a and b) summarized the data available in the period 1980 to 2007 in the Hydrobase archive (Curry, 2001) and that of the National Marine Fisheries Service (NMFS) Marine Resources Monitoring Assessment and Prediction (MARMAP) program (Mountain, 2003). Figure 8 shows the location o f the identified samples in BIS and Rhode Island Sound . There are many spring and summer samples to the south and east of BIS but very few in the ZSF.

Temperature and salinity data from the CTDEEP survey program and from the NOAA data archive will be us ed initially for FVCOM calibration. Data to be collected during the PO field study will be used, when available, for further model calibration and validation. Specifically, these data are collected by CTDs mounted on each of the seven mooring s, and also by using CTDs mounted on survey vessels to collect data during the ship track surveys.

2.7 River Discharge

The main tributaries to ELIS and BIS are the Connecticut River and the Thames River. However, simulating the circulation in the LIS adequately requires the flow rate measurements in all the major tributaries. The U.S. Geological Survey (USGS) operates a network of instruments to provide this information ; its data distribution center provides extensive data records for the State of Connecticut and similar sites are available for the States of New York and Rhode Island (http://waterdata.usgs.gov/CT/nwis/current?type=flow). The primary sources of freshwater to the LIS are the Connecticut River, the Hudson River (through the East River), the Housatonic River, the Quinnipiac River, and the Thames River. Though several flow gages in the region may not be sustained, the model will rely on data from the primary gages that are unlikely to be threatened by budget cuts.

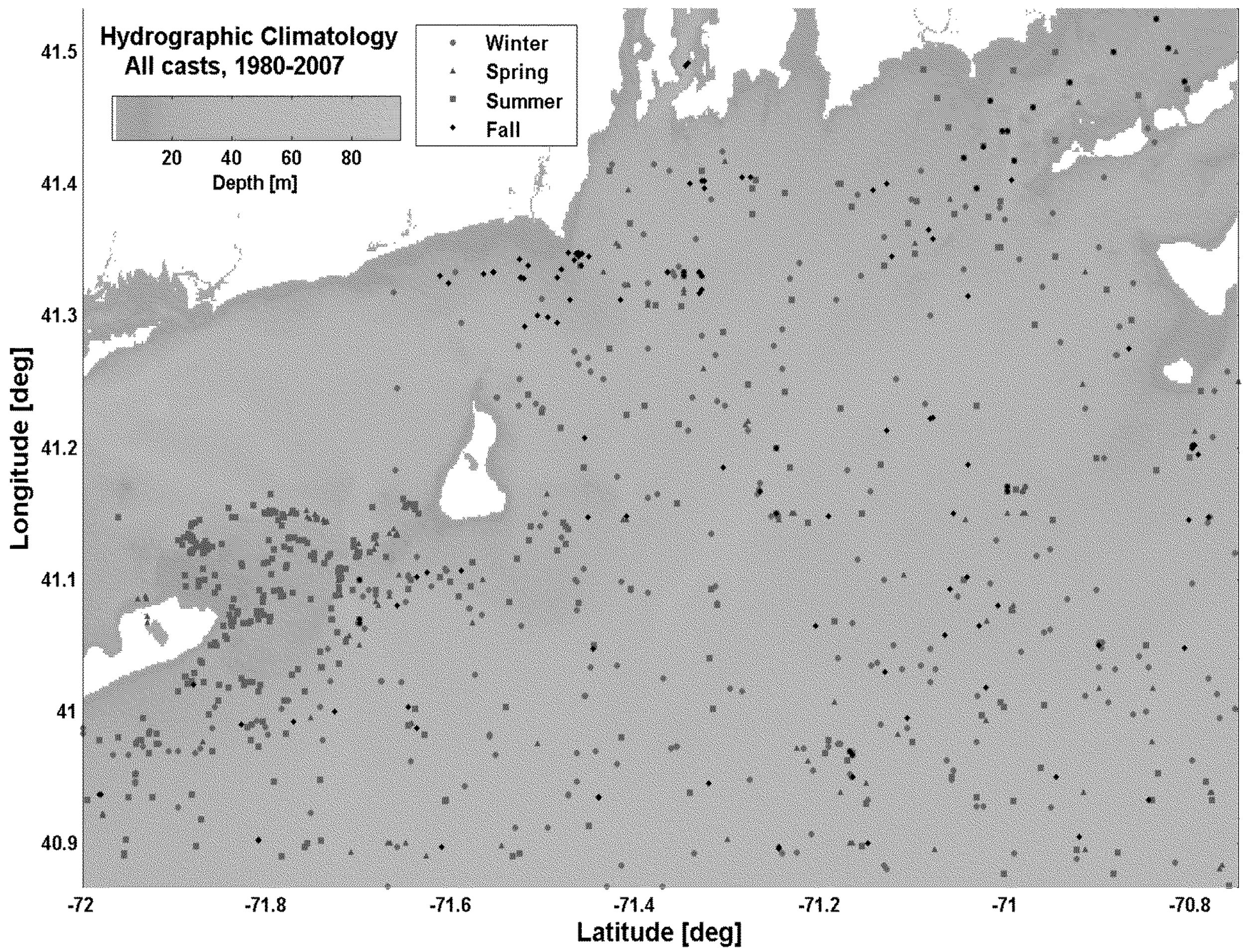


Figure 8. Location of salinity and temperature data available in BIS and Rhode Island Sound, collected during different seasons. Reproduced from Codiga and Ullman (2011a).

ED_001437D_00000426-00197

3. DATA GAPS - SUMMARY

An extensive review of available data was conducted, which included the DMMP Literature Review (WHG, 2010), that could be used to describe the physical oceanography of the ZSF. This review demonstrates that data gaps exist within the ZSF, as summarized in Table 2. Although the wind field in the ZSF and the river discharge rates are well described in the literature, there are no bottom stress measurements and no wave measurements. The circulation patterns forced by wind and fluctuations in river discharge are poorly characterized since the few available current measurements are limited to either BIS or LIS; therefore, the patterns of flow between the basins cannot be described. The seasonal variations in salinity and temperature are well characterized along the axis of LIS but little is known about the north-south structure and its variability, and there are few observations in BIS.

We conclude that a program to measure bottom stress, wave field parameters and the circulation characteristics in a wide variety of wind and river flow conditions is essential to adequately evaluate model predictions so that they can be reliably used in site assessment applications. This program is described in the PO Study QAPP (UConn and Louis Berger, 2013) and summarized in Table 2 below.

ED_001437D_00000426-00198

Table 2. Summary of Data Gaps and Proposed PO Field Study Data Collection

Parameter	Available Data / Data Gaps	Data to be Collected during PO Field Study
1. Bottom Stress	*Data/ Gaps:* Essentially no available data.	• Deployment of 7 moorings in the ZSF with near-bottom acoustic current meters for bottom stress estimation. • Refer also to Items 2 and 3 below.
2. Currents	*Data:* Available data described in Section 2.2 will be used to calibrate FVCOM. *Gaps:* The spatial and temporal extent of the available data is insufficient for model validation.	• Deployment of 7 moorings in the ZSF with ADCPs to measure current profiles. • Three ship track surveys using a hull-mounted ADCP to measure current patterns.
3. Wave Measurements	*Data:* LISICOS and CDIP buoy data for wave height, period, and direction will be used to assess FVCOM capability in wave amplitude and wave period predictions. *Gaps:* A more extensive data distribution is needed for model validation.	• Deployment of 7 moorings in the ZSF with bottom pressure sensors to collect data on wave parameters and sea level.
4. Sea Level	*Data:* Lengthy records of sea level data are available from NOAA stations at New London, CT and Montauk, NY. These data will be used to calibrate and validate FVCOM output. *Gaps:* None	• Deployment of 7 moorings in the ZSF with bottom pressure sensors to collect data on wave parameters and sea level.
5. Wind	*Data:* • Limited wind speed and direction dataset available from CLIS and ELIS buoys. • Historical wind data available from Sikorsky Airport, Bridgeport, CT. • UConn maintains directional wave buoys that will be used to provide additional data. *Gaps:* None.	None.
6. Temperature and Salinity	*Data:* Available data described in Section 2.6 will be used for FVCOM calibration. *Gaps:* None	• Deployment of 7 moorings in the ZSF with CTDs. • Three ship-track surveys with a profiling CTD mounted on the survey vessel.
7. River Discharge	USGS monitoring network for Connecticut River, Thames River, and other major tributaries to the ELIS. *Gaps*: None	None.

ED_001437D_00000426-00199

4. REFERENCES

Bennett, D.M., J. O'Donnell, W.F. Bohlen , and A.E. Houk . 2010. Tides and overtides in Long Island Sound. *Journal of Marine Research*, v. 68, p. 1-35.

Chen, C., H . Huang, R .C. Beardsley, H . Liu, Q . Xu, and G . Cowles, 2007. A finite vol ume numerical approach for coastal ocean circulation studies: Comparisons with finite difference models. *Journal of Geophysical Research* 112 (C3), C03018.

Codiga, D.L. and L.V. Rear. 2004. Observed tidal currents outside Block Island Sound: Offshore decay and effects of estuarine outflow. *Journal of Geophysical Research,* v. 109, C07S05, doi:10.1029/2003JC001804.

Codiga, D.L. and D.A. Aurin . 2006. Residual circulation in Eastern Long Island Sound: Observed transverse-vertical structure and exchange transpor t. *Continental Shelf Research*, v. 27, p. 103-116.

Codiga, D.L. and D.S. Ullman . 2011a. Characterizing the Physical Oceanography of Coastal Waters off Rhode Island, Part 1: Literature Review, Available Observations, and a Representative Model Simulation. Available at: http://seagrant.gso.uri.edu/oceansamp/pdf/appendix/02-PhysOcPart1-OSAMP-CodigaUllman2010.pdf.)

Codiga, D.L. and D. S. Ullman . 2011b. Characterizing the Physical Oceanography of Coastal Waters o ff Rhode Island, Part 2: New Observations of Water Properties, Currents, and Waves. Available at: http://seagrant.gso.uri.edu/oceansamp/pdf/appendix/03-PhysOcPart2-OSAMP-UllmanCodiga2010.pdf

Curry, R. 2001. HydroBase 2: A Database of Hydrographic Profiles and Tools for Climatological Analysis. Woods Hole Oceanographic Institution, Draft Technical Reference, ftp://flotsam.whoi.edu/HydroBase2/DOC/TechRef_draft.pdf.

Earwacker, K.L. 1990. Long Island Sound Oceanographic Project: 1988 -1990. NOS Oceanographic Circulation Survey Report No. 10. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD.

ENSR. 2001. Draft Environmental Impact Statement for the Designation of a Disposal Site for Dredged Material -Physical Oceanographic Evaluation of Long Island Sound and Block Island Sound, Appendix G -1. Prepared for U.S. Army Corps of Engineers New England Division. DACW 33-96-D-0004 (Task Order 25, Mod. 17, 18)

Gay, P.S., J. O'Donnell and C.A. Edwards. 2004. Exchange between Long Island Sound and adjacent waters. *Journal of Geophysical Research* , v. 109, C06017, doi:10.1029/2004JC002319.

ED_001437D_00000426-00200

Gay, P.S. and J. O'Donnell. 2007. A one dimensional model of the salt flux in estuaries. *Journal of Geophysical Research,* v. 112, C07021, doi:10.1029/2006JC003840

Grant, W.D. and O.S. Madsen . 1979. Combined wave and current interact ion with a rough bottom. *Journal of Geophysical Research,* v. 84, p. 1797–1808.

Grilli, S., J. Harris, R. Sharma, L. Decker, D. Stuebe, D. Mendelsohn, D. Crowley, and S. Decker. 2011. High Resolution Modeling of Meteorological, Hydrodynamic, Wave and Sediment processes in the Rhode Island Ocean SAMP study area. Available at: http://seagrant.gso.uri.edu/oceansamp/pdf/appendix/06-Grilli-SAMP-final.pdf

Ianniello, J.P. 1979. Boundary layer turbulence measurements. In: *DAMOS Disposal Area Monitoring System, Annual Data Report,* Proceedings of the Symposium, v. 1, p. 91-145.

Kaputa, N.P. and C.B. Olsen . 2000. State of Connecticut, Department of Energy and Environmental Protection, Long Island 1901 Sound Ambient Water Quality Monitoring Program: Summer Hypoxia 1902 Monitoring Survey '91-'98 Data Review.

Levine, E.R., L. Goodman, and J. O'Donnell . 2009. Turbulence in coastal fronts near the mouth of Long Island Sound. *Journal of Marine Systems,* v. 78, p. 476–488. Available at: http://nopp.dms.uconn.edu/Science/index.html

Mountain, D.G. 2003. Variability in the properties of Shelf Water in the Middle Atlantic Bight,1977-1999. *Journal of Geophysical Research-Oceans,* v. 108, p. 3014-3014.

NOAA. 2010. http://tidesandcurrents.noaa.gov/cdata/StationList?type=Current%20Data&filter=survey&pid=16

O'Donnell, J., R.E. Wilson, K. Lwiza, M. Whitney, W.F. Bohlen, D. Codiga, T. Fake, D. Fribance, M. Bowman, and J. Varekamp. 2014. The Physical Oceanography of Long Island Sound. In: *Long Island Sound: Prospects for the Urban Sea.* Latimer, J.S., Tedesco, M., Swanson, R.L., Yarish, C., Stacey, P., Garza, C. (eds.), Springer, (in press, Nov, 2013). Draft available at: http://sp.uconn.edu/~odonnell/reports/Section3FinalRev_dense.pdf

O'Donnell, J. and A. Allen. 1992. Observations of the hydrography and Lagrangian surface drift in Block Island Sound. Proceedings of the First Long Island Sound Research Conference, New Haven, Connecticut. October 23-24, 1992.

O'Donnell, J. and W.F. Bohlen 2003. The Structure and variability of the res idual circulation in Long Island Sound. Final Report 303. Conn. Dept. of Environmental Protection. Hartford, CT.

Raudkivi, A.J. 1967. *Loose Boundary Hydraulics*, Pergamon Press, 331p.

Signell, R.P., J.H. List , and A.S. Farris . 2000. Bottom currents and sed iment transport in Long Island Sound: A modeling study. *Journal of Coastal Research*, v. 16, p. 551-566.

UConn and Louis Berger (University of Connecticut and The Louis Berger Group, Inc.). 2013. Quality Assurance Project Plan for Physical Oceanography Data Collection in Eastern Long Island Sound. Revised. Prepared for the United States Environmental Protection Agency. (May 10, 2013).

Ullman, D.S. and D.L. Codiga. 2004. Seasonal variation of a coastal jet in the Long Island Sound outflow region based on HF radar and Doppler current observations. *Journal of Geophysical Research,* v. 109, C07S06, doi:10.1029/2002JC001660.

Ullman, D.S., J. O'Donnell, J. Kohut, T. Fake, and A. Allen. 2006. Trajectory prediction using HF radar surface currents: Monte Carlo simulations of prediction uncertainties. *Journal of Geophysical Research,* v. 111, C12005, doi: 10.1029/2006JCoo3715.

USEPA (U.S. Environmental Protection Agency). 2004. Final Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York. Prepared by the USEPA New England Region, in cooperation with the USACE New England District (April 2004).

Vieira, M.E.C. 2000. The long-term residual circulation in Long Island Sound. *Estuaries.* v. 23, p.199- 207.

Wang, Y-H., W.F. Bohlen and J. O'Donnell. 2000. Storm enhanced bottom shear stress and associated sediment entrainment in a moderate energetic estuary. *Journal of Oceanography*, v. 56, p. 311-317.

WHG (Woods Hole Group). 2010. Long Island Sound Dredged Material Management Plan (DMMP) – Phase 2 Literature Review Update. Contract No. W912WJ-09-D-0001, Task Order #22, Prepared for USACE-New England Division.

Winterwerp, J.C. and W.G.M. van Kesteren. 2004. Introduction to the Physics of Cohesive Sediment in the Marine Environment. Developments in Sedimentology 56. Elsevier, Amsterdam, 559p.

ED_001437D_00000426-00202

Attachment A

Physical Oceanography –Relevant Literature and Data Sources, including DMMP References*

* Data sources included from the DMMP (WHG, 2010) are marked in the column to the right.

ED_001437D_00000426-00203

	Literature/Document Source	SEIS	Data Type	DMMP *
1	Bennett DC (2010) The dynamical circulation of a partially stratified, frictional estuary: Long Island Sound. PhD Dissertation, University of Connecticut, Groton, CT, 168 pp	Description of Current observations	Currents in and near ZSF	
2	Bennett DC, O'Donnell J, Bohlen WF, Houk AE (2010) Tides and overtides in Long Island Sound. J Mar Res 68 (1):21-35	Description of Current observations	Currents in and near ZSF	
3	Blumberg AF and Pritchard DW (1997) Estimates of the transport through the East River, New York. J Geophys Res 102 (C3):5685-5703	Application of Model	None	
4	Blumberg AF, Khan LA, St. John JP (1999) Three-dimensional hydrodynamic simulations of the New York Harbor, Long Island Sound and the New York Bight. J Hydraulic Eng 125:799-816	Application of Model	None	
5	Bogden PS and O'Donnell J (1998) Generalized inverse with shipboard current measurements: Tidal and nontidal flows in Long Island Sound. J Mar Res 56 (5):995(3)	Application of Model	Currents in CLIS	
6	Bokuniewicz HJ and Gordon RB (1980a) Sediment transport and deposition in Long Island Sound. Advances in Geophys 22:69-106	Sediments in LIS	None	
7	Bokuniewicz HJ and Gordon RB (1980b) Storm and tidal energy in Long Island Sound. Advances in Geophys 22:41-67	Description of Current and stress observations in WLIS	None	
8	Codiga DL and Rear LV (2004) Observed tidal currents outside Block Island Sound: Offshore decay and effects of estuarine outflow. J Geophys Res 109, C07S05. doi:10.1029/2003JC001804	Description of currents and stratification near the ZSF	Currents near ZSF	
9	Codiga DL and Aurin DA (2006) Residual circulation in eastern Long Island Sound: observed transverse-vertical structure and exchange transport. Cont Shelf Res 27:103-116	Description of currents and stratification in the ZSF	Current measurements from ferry	●
10	Codiga DL and Ullman DS (2011) Characterizing the physical oceanography of coastal waters off Rhode Island, Part 1: Literature review, available observations, and a representative model simulation. Technical Report 2, Appendix to Rhode Island Ocean Special Area Management Plan, 169 pp	Description of currents and stratification in the ZSF	Current measurements from ferry	
11	Codiga DL, Waliser DS, Wilson RE (2002) Observed evolution of vertical profiles of stratification and dissolved oxygen in Long Island Sound. Proc New England Estuarine Research Society/Long Island Sound Research Conf. Groton, CT, 7-12	Description of currents and stratification in the ZSF	Current measurements from ferry	
12	Crowley H (2005) The seasonal evolution of thermohaline circulation in Long Island Sound. PhD Dissertation, Marine Sciences Research Center, Stony Brook University, Stony Brook, NY, 142 pp	Application of Model	None	
13	Garvine RW (1974) Physical features of the Connecticut River outflow during high discharge. J Geophys Res 79:831-846	Hydrography in ELIS	None	

ED_001437D_00000426-00204

	Literature/Document Source	SEIS	Data Type	DMMP *
14	Garvine RW (1975) The distribution of salinity and temperature in the Connecticut River estuary. J Geophys Res 80:1176-1183	Hydrography in ELIS	None	
15	Garvine RW (1977) Observations of the motion field of the Connecticut river plume. J Geophys Res 82:441-454	Hydrography and currents in ELIS	None	
16	Gay P, O'Donnell J, Edwards CA (2004) Exchange between Long Island Sound and adjacent waters. J Geophys Res, *109*, C06017, doi:10.1029/2004JC002319.	Analysis of Hydrography in ELIS	salinity and temperature profiles	
17	Gay PS and O'Donnell J (2007) A one-dimensional model of the salt flux in estuaries. J Geophys Res 112, C07021. doi:10.1029/2006JC003840	Analysis of Hydrography in ELIS	salinity and temperature profiles	
18	Gay PS and O'Donnell J (2009) Comparison of the salinity structure of the Chesapeake Bay, the Delaware Bay and Long Island Sound using a linearly tapered advection-dispersion model. Estuaries and Coasts 32:68-87. doi:10.1007/s12237-008-9101-4	Analysis of Hydrography in ELIS	salinity and temperature profiles	
19	Gordon RB and Pilbeam CC (1975) Circulation in central Long Island Sound. J Geophys Res 80:414-422	Transport in CLIS	None	
20	Gross MG and Bumpus DF (1972) Residual drift of near bottom waters in Long Island Sound. Limnol and Oceanogr 11:636-638	Transport in CLIS	None	
21	Hao Y (2008) Tidal and residual circulation in Long Island Sound. PhD Dissertation, Marine Sciences Research Center, Stony Brook University, Stony Brook, NY, 70 pp	Application of Model	None	
22	Hardy CD (1972) Hydrographic data report: Long Island Sound, 1970, Part II. Marine Sciences Research Center, State University of New York, Stony Brook, NY, 20pp.	Transport in ZSF	Drift Bottle locations	
23	Hollman R and Sandberg GR (1972) The residual drift in eastern Long Island Sound and Block Island Sound. New York Ocean Sci Lab Tech Rept 15, 19pp.	Transport in ZSF	Drift Bottle locations	
24	Howard-Strobel MM, Bohlen WF, Cohen DR (2006) A year of Acoustic Doppler Current Meter observations from Central Long Island Sound. 8th Biennial Long Island Sound Research Conference Proceedings 2006, 26-31	Currents in CLIS	Currents near ZSF	
25	Ianniello JP (1977a) Non-linearly induced residual currents in tidally dominated estuaries. PhD Dissertation, The University of Connecticut, 250pp.	Application of Model	None	
26	Ianniello JP (1977b) Tidally induced residual currents in estuaries of constant breadth and depth. J Mar Res 35 (4):755-785	Application of Model	None	
27	Jay DA and Bowman MJ (1975) The physical oceanography and water quality of New York Harbor and western Long Island Sound. Technical Report 23, Ref # 75-7, Marine Sciences Research Center, State University of New York, Stony Brook	Currents in and Hydrography in WLIS	None	

ED_001437D_00000426-00205

	Literature/Document Source	SEIS	Data Type	DMMP*
28	Kaputa NP and Olsen CB (2000) State of Connecticut Department of Environmental Protection, Long Island Sound Ambient Water Quality Monitoring Program: Summer Hypoxia Monitoring Survey '91-'98 Data Review, CTDEP Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127, 45 pp.	Description of Hydrography in LIS	salinity and temperature profiles	
29	Kenefick AM (1985) Barotropic M2 tides and tidal currents in Long Island Sound: A numerical model. J Coast Res 1:117-128	Application of Model	None	
30	Larkin RR and Riley GA (1967) A drift bottle study in Long Island Sound. Bull Bingham Oceanogr Coll 19:62-71	Description of transport in ZSF	Drift Bottle locations	
31	Lee YJ (2009) Mechanisms controlling variability in Long Island Sound. PhD Dissertation, School of Marine and Atmospheric Sciences, Stony Brook University, New York, 147pp.	Application of Model	None	
32	Lee YJ and Lwiza K (2005) Interannual variability of temperature and salinity in shallow water: Long Island Sound, New York. J Geophys Res 110. doi:10.1029/2004JC002507	Analysis of Hydrography in LIS	None	●
33	Lee YJ and Lwiza KMM (2008) Characteristics of bottom dissolved oxygen in Long Island Sound, New York. Estuar Coast Shelf Sci 76:187-200. doi:10.1016/j.ecss.2007.07.001	Analysis of Hydrography in LIS	None	
34	Le Lacheur EA and Sammons JC (1932) Tides and currents in Long Island and Block Island Sounds. U.S. Coast and Geodetic Survey, Special Publication 174	Currents in and Hydrography in WLIS	drift pole measurements in LIS	
35	Li CY and O'Donnell J (1997) Tidally driven residual circulation in shallow estuaries with lateral in shallow estuaries with lateral depth variation. J Geophys Res 102:27915-27929	Application of Model	None	
36	Li C and O'Donnell J (2005) The effect of channel length on the residual circulation in tidally dominated channels. J Phys Oceanogr 35:1826-1840	Application of Model	None	
37	Mau J-C, Wang D-P, Ullman DS, Codiga DL (2008) Model of the Long Island Sound outflow: Comparison with year-long HF radar and Doppler current observations. Cont Shelf Res 28 (14):1791-1799. doi:10.1016/j.csr.2008.04.013	Application of Model	None	
38	McCardell GM and O'Donnell J (2009) A novel method for estimating vertical eddy diffusivities using diurnal signals with application to western Long Island Sound. J Mar Systems 77:397–408	Description of buoy records in WLIS	None	
39	Murphy DL (1979) A numerical investigation into the physical parameters which determine the residual drift in Long Island Sound. PhD Dissertation, Dept of Marine Sciences, The University of	Application of Model	None	
40	O'Donnell J (1997) Observations of near surface currents and hydrography in the Connecticut River plume with the SCUD array. J Geophys Res 102:25021-25033	Currents in and Hydrography in ELIS	None	

ED_001437D_00000426-00206

	Literature/Document Source	SEIS	Data Type	DMMP*
41	O'Donnell J and Bohlen WF (2003) The structure and variability of the residual circulation in Long Island Sound. Final Report, Connecticut Department of Environmental Protection, Hartford, CT. Grant CWF 325-R, 303 pp (http://www.lisrc.uconn.edu/DataCatalog/DocumentImages/pdf/Odonnell_Bohlen_2003.pdfhttp://www.lisrc.uconn.edu/DataCatalog/DocumentImages/pdf/Odonnell_Bohlen_2003.pdf)	Currents in and Hydrography in ELIS	Current Measurements, salinity and temperature profiles near ZSF	
42	O'Donnell J, Marmorino GO, Trump CL (1998) Convergence and downwelling at a river plume front. J Phys Oceanogr 28:481-1495	Currents in and Hydrography in ELIS	Current Measurements, salinity and temperature profiles near ZSF	
43	O'Donnell J, Bohlen WF, Dam HG (2006) Wind stress and the ventilation of the hypoxic zone of western Long Island Sound. Proc 8th Biennial Long Island Sound Research Conference, CT Sea Grant Program, New London, CT	Currents in and Hydrography in WLIS	Current Measurements, salinity and temperature profiles near ZSF	
44	O'Donnell J, Dam HG, Bohlen WF, Fitzgerald W, Gay PS, Houk AE, Cohen DC, Howard-Strobel MM (2008) Intermittent ventilation in the hypoxic zone of western Long Island Sound during the summer of 2004. J Geophys Res 113. doi:10.1029/2007JC004716	Currents in and Hydrography in WLIS	Current Measurements, salinity and temperature profiles near ZSF	
45	O'Donnell J, Ackleson SG, Levine ER (2008) On the spatial scales of a river plume. J Geophys Res-Oceans 113, C04017. doi:10.1029/2007JC004440	Currents in and Hydrography in ELIS	Current Measurements, salinity and temperature profiles near ZSF	
46	O'Donnell J, Morrison J, Mullaney J (2010) The expansion of the Long Island Sound Integrated Coastal Observing System (LISICOS) to the Connecticut River in support of understanding the consequences of climate change. Final Report to the CTDEP, LIS License Plate Fund, 20pp.	Analysis of Hydrography in CT River	River Discharge, Salinity and temperature time series	
47	Paskausky DF (1976) Seasonal variation of residual drift in Long Island Sound. Est Coast Mar Sci 4:513-522	Currents in and Hydrography in WLIS	drift bottle measurements in LIS	
48	Riley GA (1952) Hydrography of the Long Island and Block Island Sounds. Bull of the Bingham Oceanographic Collection 13, Article 3, Peabody Museum of Natural History, Yale University, New Haven, CT	Hydrography in LIS	salinity and temperature profiles in CLIS	

ED_001437D_00000426-00207

	Literature/Document Source	SEIS	Data Type	DMMP*
49	Riley GA (1956) Oceanography of Long Island Sound: 1952-1954. II. Phys Oceanogr Bull of the Bingham Oceanographic Collection 15, Peabody Museum of Natural History, Yale University, New Haven, CT	Hydrography in LIS	salinity and temperature profiles in CLIS	
50	Rivera Lemus ER (2008) Wind waves in central Long Island Sound: a comparison of observations to an analytical expression. Masters Dissertation, Department of Marine Sciences, The University of Connecticut, 77 pp	Description of wind and wave in CLIS	Buoy data on waves and wind	
51	Schmalz RA (1993) Numerical decomposition of Eulerian circulation in Long Island Sound. In: Proceedings of the 3rd International Estuarine and Coastal Modeling Conference. ASCE, Chicago, IL, 294-308 pp.	Application of Model	None	
52	Signell R, List J, Farris A (2000) Bottom currents and sediment transport in Long Island Sound: a modeling study. J Coast Res 16:551–566	Application of Model	None	
53	Swanson RL (1976) Tides. MESA New York Bight Atlas Monograph, 4, New York Sea Grant Institute, Albany, NY, 34pp.	Description of tides in LIS	None	
54	Torgersen T, DeAngelo E, O'Donnell J (1997) Calculations of horizontal mixing rates using 222Rn and the controls on hypoxia in western Long Island Sound. Estuaries 20:328-343	Dispersion in WLIS	None	
55	Ullman DS and DL Codiga DL (2010) Characterizing the physical oceanography of coastal waters off Rhode Island, Part 2: New observations of water properties, currents, and waves. Technical Report 3, Appendix to Rhode Island Ocean Special Area Management Plan, 108 pp	Review of Physical Oceanography in BIS	None	
56	Ullman DS and Wilson RE (1984) Subinertial current oscillations in western Long Island Sound. J Geophys Res 89:10,579-10,587	Application of Model	Current data from WLIS	
57	Valle-Levinson A and Wilson RE (1994a) Effects of sill bathymetry, oscillating barotropic forcing and vertical mixing on estuary ocean exchange, J Geophys Res 99 (C3):5194-5169	Application of Model	None	
58	Valle-Levinson A and Wilson RE (1994b) Effects of sill processes and tidal forcing on exchange in eastern Long Island Sound. J Geophys Res 99 (C6):12667-12681	Application of Model	None	
59	Valle-Levinson A, Wilson RE, Swanson RL (1995) Physical mechanisms leading to hypoxia and anoxia in western Long Island Sound. Environment International, 21 (5):657-666	Application of Model	None	
60	Vieira MEC (2000) The long-term residual circulation in Long Island Sound. Estuaries 23 (2):199-207	Summary of Current observations in LIS	None	
61	U.S. Environmental Protection Agency (2004) Environmental Impact Statement for the Designation Of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York	EIS, includes general information about PO of LIS		●

ED_001437D_00000426-00208

	Literature/Document Source	SEIS	Data Type	DMMP*
62	Wang YH, Bohlen WF, O'Donnell J (2000) Storm enhanced bottom shear stress and associated sediment entrainment in a moderate energetic estuary. J Oceanogr **56**:311-317	Observations and model of waves and currents ant the New haven Dump Site	None	
63	Welsh BL and Eller FC (1991) Mechanisms controlling summertime oxygen depletion in western Long Island Sound. Estuaries 14:265-278	Hydrography in WLIS	None	
64	Whitney MM (2010) A study on river discharge and salinity variability in the Middle Atlantic Bight and Long Island Sound. Cont Shelf Res 30:305-318	Analysis of river and salinity fluctuations in LIS	None	
65	Whitney MM and Codiga DL (2011) Response of a large stratified estuary to wind events: Observations, simulations, and theory for Long Island Sound. J Phys Oceanogr 41:1308-1327	Model and observations in ELIS	None	
66	Wilson RE (1976) Gravitational circulation in Long Island Sound. Estuar Coast Mar Sci 4:443-453	Application of Model	None	
67	Wilson RE and Swanson RL (2005) A perspective on bottom water temperature anomalies in Long Island Sound during the 1999 Lobster Mortality event. J Shellfish Res 24:825-830	Application of Model	None	
68	Wilson RE, Crowley HA, Brownawell BJ, Swanson RL (2005) Simulation of transient pesticide concentrations in Long Island Sound for late summer 1999 with a high resolution coastal circulation model. J Shellfish Res 24:865-875	Application of Model	None	
69	Wilson RE, Swanson RL, Crowley HA (2008) Perspectives on long-term variations in hypoxic conditions in western Long Island Sound. J Geophys Res113:C12011. doi:10.1029/2007JC004693	Analysis of temperature and dissolved oxygen in WLIS	None	
70	Wong K-C (1990) Sea level variability in Long Island Sound. Estuaries 13: 362-372	Application of Model	None	
71	Wong K-C (1991) The effect of the East River on the barotropic motions in Long Island Sound. J Mar Res 49:321-337	Application of Model	None	

* *Documents included in: WHG (Woods Hole Group). 2010. Long Island Sound Dredged Material Management Plan, Phase 2 Literature Review Update. Prepared for the U.S. Army Corps of Engineers (June 2010).*